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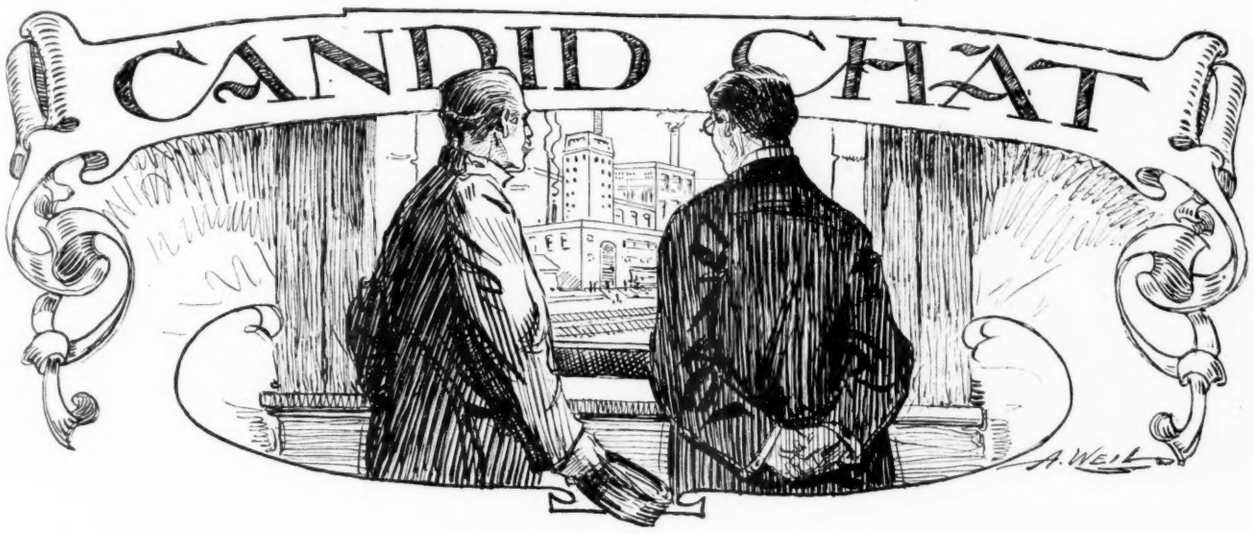


Safety and Conservation

The engineer in charge of a modern power plant has much depending upon him. He has the safety of life and limb, the protection of property and the conservation of fuel and power in his hands. And with the doctrine of democracy that is being spread at the present time, at the cost of many lives of true American sons, and of many millions of dollars, he should not only do his very best, but should use his influence to get all identified with his plant to do the same.

One of the necessary visitors to the power plant is the boiler inspector. The true inspector of today feels that he is his brother's keeper, in a sense, and the engineer should feel the same in his position. Thoroughness is the big word with the sincere inspector—thoroughness of inspection, thoroughness in reporting conditions as found, and thoroughness in recommending repairs and alterations.

Many lives have been saved and much property damage prevented by the timely discovery of dangerous defects in steam boilers by the careful boiler inspector, although it may have become known to but few people. The owner does not want it known that he has had a dangerous boiler in his plant, as it is no credit to the engineer. So silence is encouraged. Experience has proved, however, that many boiler accidents could have been prevented and the lives of many boilers prolonged for years if periodical inspection had been made by competent inspectors.

If a manager wants pointers on profits, tell him that safety is the sane and substantial base to build upon. Safety is the big brother of economy and efficiency.

We are at war against waste and we are all soldiers in the same service, whether in the trenches on a foreign battlefield or in the factories of America, whether in a battleship on the ocean or in a power plant in a village at home. Constant conservation is the command.

To conserve is to guard, preserve and protect. In this colossal charge against the criminals who are opposed to civilization let us not sacrifice safety in our endeavor for economy and efficiency. Turn the searchlight of safety on the dragon of waste, and remember that scale, soot, air leaks, poor combustion and steam leaks are all allies of the Kaiser, and general carelessness in this country is a valuable servant of Prussianism.

Do not make the mistake of trying to operate valuable modern up-to-date machinery by cheap unskilled labor. Remember that it requires a liberal percentage of horse sense to produce a high percentage of horsepower. You could not expect to win a race by hitching a cart horse to a high-priced sulky. As it requires brains and skill to devise and perfect the efficient modern machinery of our steam plants, it will also require men of experience and intelligence to operate them successfully.

The following should be posted in the front page of every engineer's logbook:

Heavy scale in the steam boiler caused the closing down of a packing house for nearly one week.

A faulty water column on a steam boiler put a laundry out of business for one week.

A defective safety valve caused a boiler explosion, resulting in loss of life, considerable property damage, and idleness of a large coal mine for several weeks.

A defective governor caused a flywheel explosion, closing down an ice plant for several weeks.

Watch your knitting and don't drop a stitch, and we will soon have the Kaiser sewed up. Capture and convert every B.t.u. into the ranks of the kw. Clean and inspect boilers by the calendar. Examine the fittings and piping for leaks. Let the password of your plant be thoroughness, and aim to have a high factor of safety in the attendants as well as in the boilers and other machinery.

Enter into hearty coöperation with the management, with the assistants, the Fuel Administration, the boiler and factory inspector, and all others who are for America, safety and conservation.

Contributed By J. A. Snyder

Cedar Rapids Big Steam Plant

A 16,000-kw. turbine plant giving commercial and railway service, bleeding steam for heating and supplying large quantities of live steam for cooking. Underfeed stokers are successfully burning Iowa and Illinois coals. Generation of current is two-phase 2300-volt and long-distance distribution is three-phase 6600- and 33,000-volt.

CEDAR RAPIDS is headquarters for the Iowa Railway and Light Co., the largest public utility in the state. Its services, consisting of electric light and power, interurban and street-railway current, gas and steam heating, extend into 19 counties forming a territory about 200 miles long and 75 miles wide in the central portion of the state. The largest steam station of the system is at Cedar Rapids and here, too, is the automatic hydro-electric plant of the company, described in the Dec. 11, 1917, issue of *Power*. The former has a rather interesting history, developing from a small noncondensing engine plant from which the exhaust steam was used for district heating to a modern condensing-turbine station of 16,000-kw. capacity. Steam for heating is bled from two of the turbines and as it is distributed through a single-pipe system it is not returned to the plant. An unusual service for a central station is the daily supply of 600,000 to 800,000 lb. of live steam at boiler pressure to the near-by plant of the Quaker Oats Co. during the winter months and about half this quantity in summer. Incidentally, 50,000 to 60,000 kw.-hr. of electrical energy per day is also supplied the company, the substation in the customer's premises being one of the largest low-voltage alternating-current installations in the country.

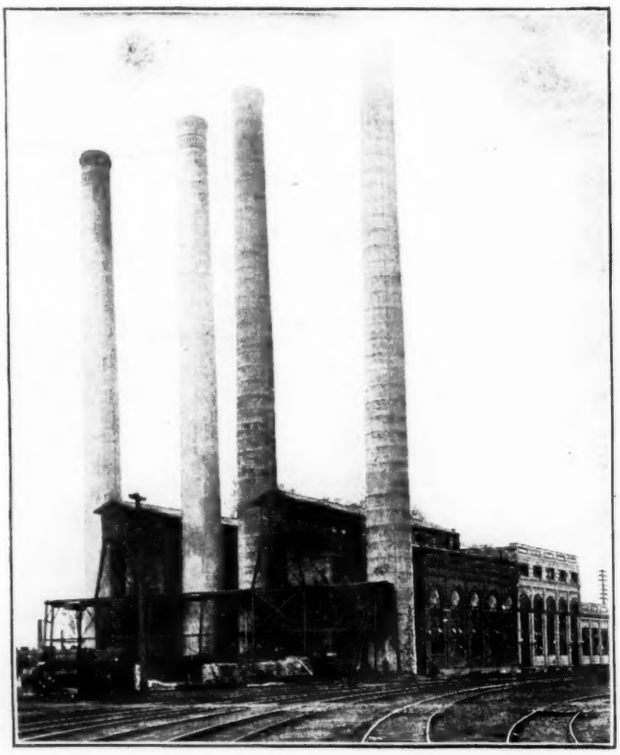


FIG. 1. SIXTH STREET STATION, CEDAR RAPIDS

Outside steam requirements called for a boiler plant larger than that demanded by the generating capacity. The later boilers installed are equipped with underfeed stokers, and in the burning of Iowa and Illinois coals they offer an interesting comparison with the chain grates remaining in the older section.

Two-phase current at 2300 volts is generated in the plant and by means of Scott connected transformers three-phase distribution is effected. Before the recent remodeling of the plant a change from two- to three-phase generators was seriously considered, but the investment in motors that would have been required made the financial aspect rather unfavorable. Features of the electrical end are two-phase-three-phase relay practice and a system operator's room from which all high-tension lines are controlled. Throughout the plant generous use has been made of instruments.

In the early days the plant supplied light, power and steam heating for the city. The equipment was two 400-kw. and one 800-kw. engine-generating units operated condensing in the summer months and in the winter supplying the exhaust steam for heating. Taking over of the street-railway load added a 1500-kw. turbo-generator to the plant, and a little later two 3500-kw. turbine units of the bleeder type were installed to care for the increasing load and the heating system as well. Supplying the heating steam at an average of 15 lb. from the turbines eliminated the trouble that had been experienced previously from oil and impurities throughout the system and reduced to a great extent the labor required for maintenance. From the operating standpoint there was another advantage. In case of boiler trouble or an insufficient supply of steam reducing the pressure, the turbines could be operated condensing at their full economy and the bleeder connections closed until the steam pressure was back to normal.

In 1914 and 1915 the contract was taken to supply the plant of the Quaker Oats Co. with current for light and power and live steam for cooking, heating and for all purposes. The quantity of steam furnished has been given previously. It is supplied to the plant through an 8-in. extra-heavy pipe at boiler pressure of 200 lb. and 100 deg. of superheat. With approximately two-thirds of the maximum daily quantity, 800,000 lb., supplied during the day period, the velocity of the steam is over 6000 ft. per min. and at times no doubt exceeds this figure. The drop is about 10 lb. and at the existing pressure at the receiving end it is superheated. The pipe is about 1220 ft. long including a large U-bend at the center to care for expansion. It is laid in a concrete box 5 ft. in the ground and is insulated with a 2½-in. asbestos covering. As the expansion in 1220-ft. run would be considerable, the pipe is laid on rollers to permit free movement. Condensation is brought back to the power plant and with it makeup water from the river. This line has been in operation for nearly four years and has never developed any trouble or leaks.

The large addition to the demands on the plant and the growth of the system throughout the state called for more capacity and made it necessary to remodel the plant, Fig. 1. An addition was made to the boiler room, more than doubling its capacity, and the turbine room was entirely rebuilt. The steelwork was put up inside the old walls, holes cut in the roof allowing it to pass through. The old roof was supported by this steelwork while the new walls and roof were being built and upon their completion was torn out.

The new turbine room, Fig. 2, measured 56 ft. wide, 140 ft. long and 35 ft. high to the bottom of the roof girders, exclusive of an addition for the switchboards, bus structures and offices.

Throughout the reconstruction service was maintained by the three turbo-generators. The engine units were removed and in 1917 a new turbo-generator rated sq.ft. per kilowatt, a ratio conforming with late practice. The circulating pump, having a capacity of 15,000 gal. per min., is driven by a 100-hp. motor, while the combination air and condensate pump is turbine-driven. As a reserve there is also an air pump and a motor-driven auxiliary hotwell pump.

All circulating pumps are connected to a common header, so that any combination of the four pumps may be used to meet the requirements of the units in operation. At times the pumps belonging to the bleeder turbine installation will fulfill the demand. Again the pump for the large unit and perhaps the small pump may be used, so that the arrangement is flexible and results in saving considerable power.

Natural cooling ponds for the condenser water is an advantage possessed by the plant. Through a concrete tunnel the water is drawn from the nearest pond, about

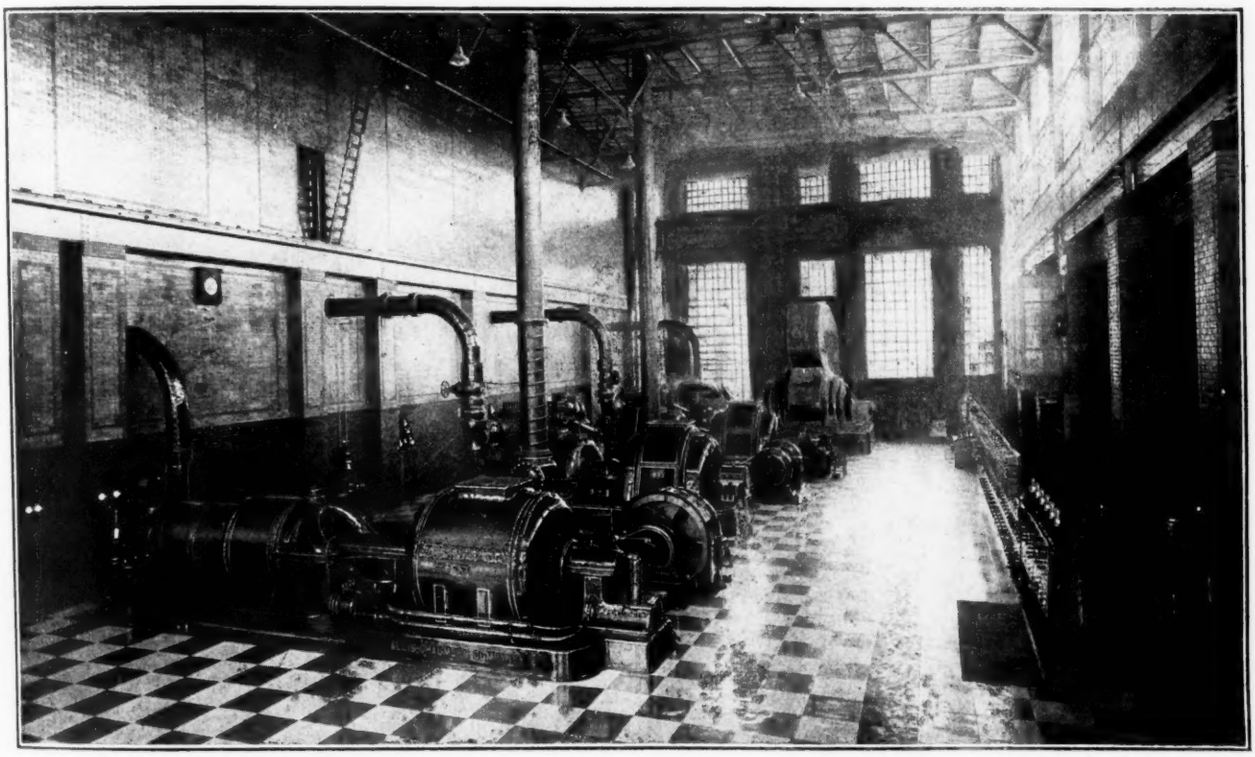


FIG. 2. GENERAL VIEW OF THE TURBINE ROOM OF THE CEDAR RAPIDS PLANT

at 7500 kw. was installed, making the present capacity of the plant 16,000 kw. All the units are two-phase 60-cycle machines having a speed of 1800 r.p.m. and generating at 2300 volts. The condensers are of the surface type. The one serving the 1500-kw. turbine has 5000 sq.ft. of surface, or 3⅓ sq.ft. per kilowatt of rating. It was installed years ago when a liberal ratio was employed because the air pumps were less efficient and the temperature of injection water high. An 8 and 16 by 20-in. dry-vacuum pump is the only steam-driven auxiliary serving the unit. Both the circulating pump, having a capacity of 5000 gal. per min., and a 3-in. condensate pump, are motor-driven.

Auxiliaries for the two bleeder turbines are duplicates. Each condenser has 10,500 sq.ft. of surface, reducing to 3 sq.ft. per kilowatt. The pumps are partly steam- and partly motor-driven. The condenser serving the new unit has 13,000 sq.ft. of surface or 1.73

100 ft. distant, and is discharged to a second pond connected with the first, the water traveling nearly a mile before it is returned to the intake.

It will be seen that there is a fair division between the electric- and steam-driven auxiliaries, the latter being required to maintain the heat balance. In this connection two of the three exciter sets are steam-driven —one rated at 100 kw. by a high-speed engine and a 150-kw. exciter by a turbine through reduction gearing, the ratio being 7200 to 900. The third exciter is rated at 75 kw. and is motor-driven. All pumps are direct-acting or turbine-driven, the forced-draft fans are engine-driven, as are the stokers which they serve. The chain-grate stokers installed in the older portion of the boiler room are driven by two 5-hp. motors, each serving four boilers, and in addition two auxiliary engines are provided as emergency drive units.

From these various sources there is considerable

exhaust steam available to heat the feed water and during the heating season it is badly needed. To illustrate, 70,000,000 lb. of steam was delivered to the heating system last January, and as none of the condensation is returned to the plant, the same amount of makeup had to be heated from an average temperature of 40 to 210 degrees, without the assistance of an economizer. The total steam generated was 150,000,000 lb., so that the percentage of makeup was nearly 50 per cent. From the Quaker Oats plant the returns mixed with makeup water from the river are brought back to the boiler room at a temperature of about 100 degrees.

The continued use of so much raw water with its consequent deposits of scale and fouling of boiler tubes is another disadvantage under which the plant must operate. In an ordinary plant a water softener would relieve the trouble, but in the present case, where both steam and electricity are sold in varying quantities, it was found that a water softener having normal treating capacity and feeding separately into the heater, rather aggravated instead of relieving the trouble. The amount of steam sold varied so much that when the water was treated to a certain degree of hardness for one proportion of condensation, within an hour this proportion would be so changed that the water would be too soft and priming and foaming would occur, carrying the impurities from the boiler over to the turbines. Settling basins of large capacity in which the condensation and treated water could be thoroughly mixed before entering the heater are being considered, as it is believed that such a plan would relieve the situation.

In the older section of the plant there were eight water-tube boilers arranged four on each side of a central firing aisle. Two of the boilers are rated at 400 hp. and the other six at 500 hp. each. They are served by chain-grate stokers having areas of 81 and 100 sq.ft., respectively. The two smaller boilers have Sewell baffling and the larger ones are vertically baffled for three passes, the type of setting being shown in Fig. 4. To the bottom of the front header the headroom is 8 ft., but a flat ignition arch extending well into the furnace reduces considerably the volume of the combustion chamber. At the stoker gate the headroom is 11 in. and at the rear of the arch 16 in. Between the arch and a corbeled bridge-wall there is a comparatively nar-

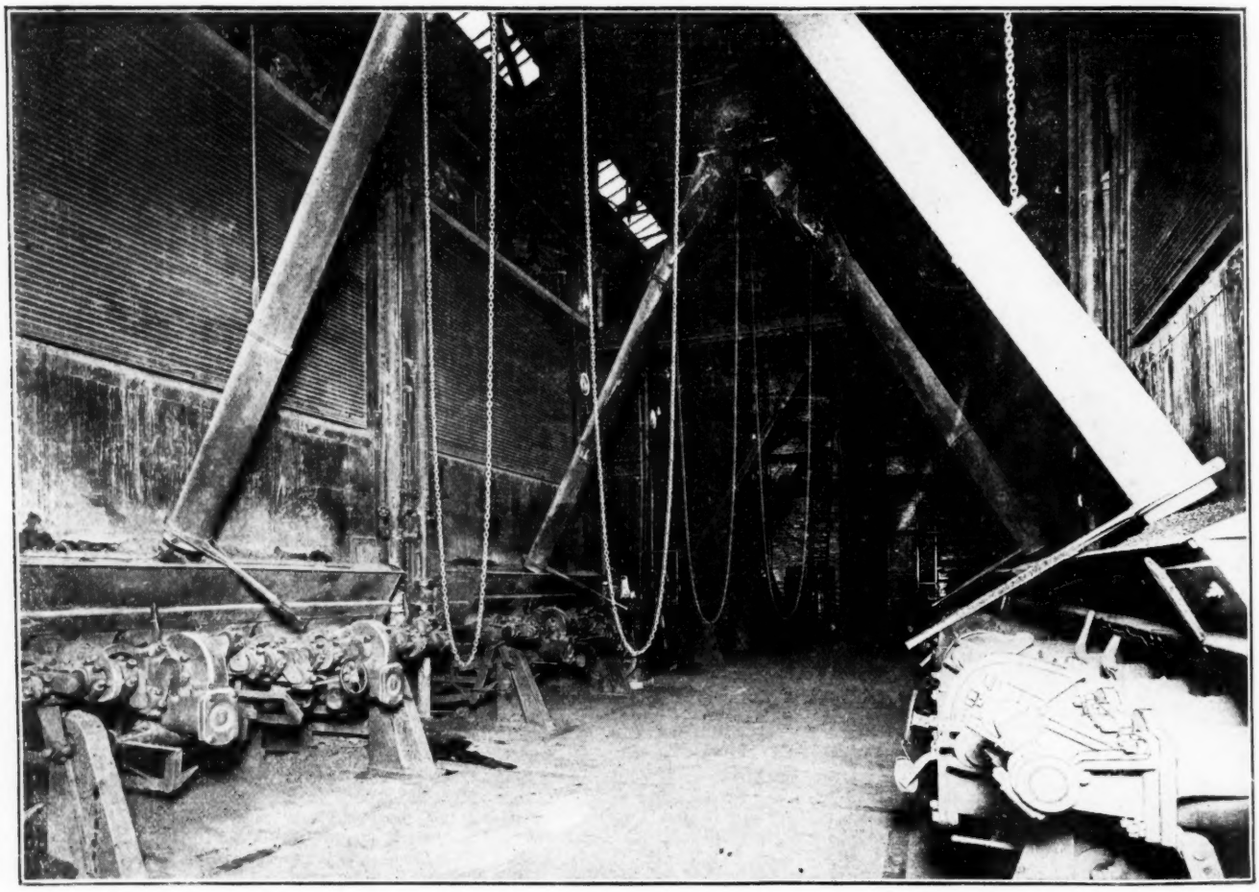


FIG. 3. NEW ADDITION TO THE BOILER ROOM; BOILERS EQUIPPED WITH UNDERFEED STOKERS

row throat to mix the gases and beyond larger volume expanding toward the tubes. With Kentucky and good grades of Illinois coal fair results were obtained from these settings, but with Iowa and certain Illinois coals, low in heat value and high in volatile, it proved difficult to maintain the boilers at 150 per cent. of rating.

In making the addition to the boiler room, stokers that would respond to quick changes in load and would operate at considerable overload with Iowa coal were desired and the choice was allotted to underfeed stokers with large power-operated dump plates. Seven-retort stokers serve water-tube boilers rated at 627 horsepower, Fig. 3. As shown in Fig. 5, the stoker is set flush with the boiler front, and with straight walls front and rear the combustion space is as large as the

headroom of 10 ft. will permit, the volume approximating 880 cu.ft. In accordance with recent practice the first baffle slopes toward the boiler front to give contracting volumes in the first and second passes as the gases cool.

Operating at boiler rating each stoker burns from 2500 to 3000 lb. of coal per hour, depending somewhat upon the fuel used, and upon occasion as high as 7400

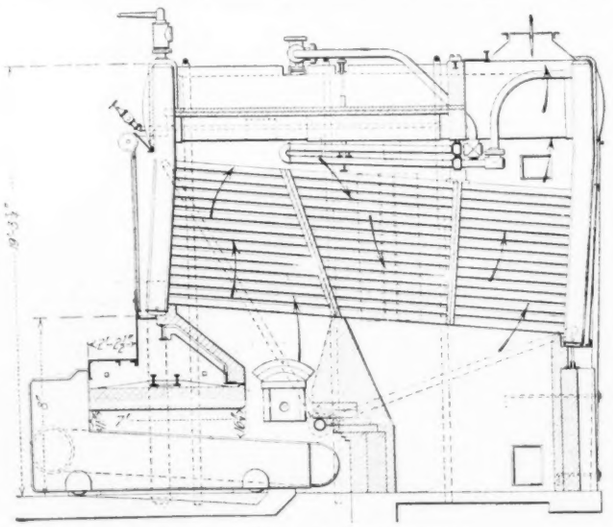


FIG. 4. CHAIN-GRATE SETTING

lb. of coal per hour has been burned, or over 1000 lb. per retort. The furnace volume, on the bases of 3000 and 7400 lb., reduces to 0.2933 and 0.1119 cu.ft. per pound of coal burned per hour. An equivalent grate area of 94.5 sq.ft. is credited to the stoker. The steam-making surface in the boiler is 6270 sq.ft., so that the ratio is 1 to 66.4. Referring to the figures on fuel consumption previously given, 31.7 and 78.1 lb. of coal respectively were burned per hour per square foot of grate.

Some indication of the flexibility of operation is given by Figs. 6 to 8, which are plots of tests made at the point by the manufacturer of the stoker. Fig. 6 shows results from Routt County, Colorado, coal of the analysis given. With the stoker operating at nearly boiler rating, a sudden demand for steam occurs. The rating is increased as rapidly as possible and thereafter high rates of steaming are required at intervals. In the test with Colorado lignite, shown in Fig. 7, the stoker was started from a "dead bank." A high output was required for a short interval and the load goes off completely. The stoker is banked for an hour and is then called upon to meet a sudden and long-continued demand. Fig. 8 shows results from Springfield, Ill., coal; with the stoker operating at 150 per cent. of rating for three hours, the load was dropped to zero, then the maximum output was developed in the shortest possible time and the load was again dropped.

Of numerous eight-hour tests conducted about the same time, one was made with Iowa slack coal from the Lakonta district. The proximate analysis gave: Moisture, 9.7 per cent.; volatile, 26.2 per cent.; fixed carbon, 36.8 per cent.; ash, 27.3 per cent.; B.t.u. per pound of coal as fired, 9130. Operating on an average rating of 168 per cent., 4875 lb. per hour of coal as fired was burned, at a combined efficiency of 79.3 per cent. With Springfield, Ill., slack of 9840 B.t.u. as fired, 12 per cent. moisture, 26 per cent. volatile matter, 45.6 per cent. fixed carbon and 16.4 per cent. ash, 7400 lb. was burned per hour to maintain a load averaging 252 per cent. of rating at a combined efficiency of 72.5 per cent.

It is quite evident that the stokers will care for quick changes in load and will maintain at high efficiency heavy overloads, when burning inferior coal. As to clinkers the boiler-room force report no more trouble in proportion to the coal burned than with the chain-grate stokers.

Without rearranging the entire layout of the plant it was impossible to install the new boilers along the central firing aisle of the older section, due to limitations imposed by railways on either side. Consequently, in the new section the layout was duplicated, a central firing aisle with four boilers on a side. Seven of these boilers have been installed and the other is on order. When it has been placed in service, there will be in the entire boiler room, measuring 80 x 142 ft., four rows of four boilers each, with two firing aisles and duplicate coal- and ash-handling facilities with cross-over connections. The operating pressure is 200 lb. and the superheat 100 degrees.

Each row of boilers is served by a concrete stack 10 ft. diameter at the top and 210 ft. high. In each case a straight smoke flue connects the four boilers with their respective stack. It is suspended over the boilers from the beams of the ceiling, a 16-in. thimble intervening between the flue and each boiler uptake. The

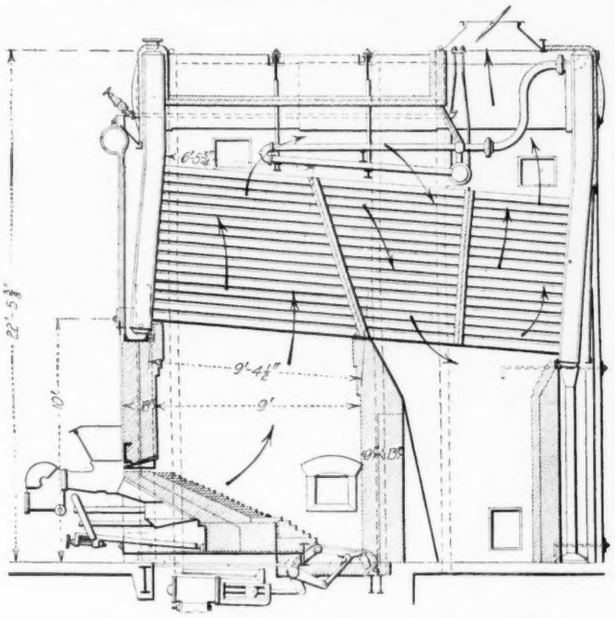


FIG. 5. SETTING FOR UNDERFEED STOKER

flue is made of steel, unprotected and is of tapering section, those in the new addition being 5 ft. 4 in. by 8 ft. 4 in. at the far end and 6 ft. 6 in. by 15 ft. at the opening into the stack. The flues serving the chain-grate installation are 5 x 6 ft. and 6.5 x 13 ft. respectively. These dimensions give stack openings of 84.5 and 97.5 sq. ft. as compared to 78.54 sq.ft., the area of each stack. Per 1000 sq.ft. of steam-making surface there are on the chain-grate side of the plant 2.224 sq.ft. of smoke-flue area, 2.07 sq.ft. of stack area and

20.05 sq.ft. of connected grate. On the underfeed-stoker side the areas in the same order are 1.94, 1.56 and 15.07.

To the completed row of four boilers in the new addition forced draft is supplied by engine-driven fans having individual capacities of 21,000 cu.ft. per min.

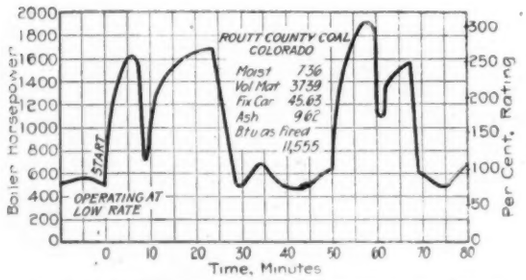


FIG. 6. FLEXIBILITY TEST BURNING ROUTT COUNTY, COLORADO, COAL

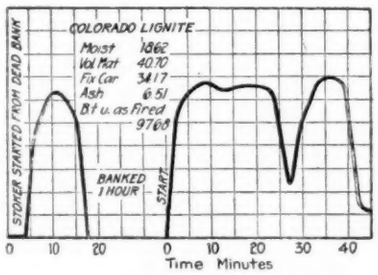


FIG. 7. TEST WITH COLORADO LIGNITE

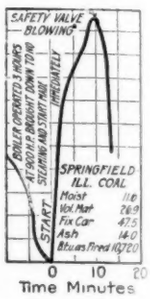


FIG. 8. BUILDING UP QUICKLY

Each fan has capacity to supply two boilers, leaving one in reserve. All three fans discharge into a single duct dampered so that any fan may be used on either pair of boilers. On the uncompleted row of boilers there are two fans, each having a capacity of 26,000 cu.ft. per min. It is the intention to install a third fan that will have capacity to care for the four boilers, leaving the other two in reserve. The fan engines are controlled by pressure governors.

It had been the practice to drive the stokers from the fan engines through a lineshaft and chain connections, but with changing fuels, requiring different ratios of air, it was found desirable to separate the two services. Stoker engines are now being installed on the boiler-room floor, with chain connections to lineshafts in the basement and driving chains from shaft to stoker. One engine will serve two boilers.

On account of the two firing aisles and two delivery tracks, one perpendicular to the firing aisles and the other parallel, the coal- and ash-handling equipment is rather complicated. Primarily, the system consists of two continuous bucket conveyors, one serving each firing aisle, with two crossover belt conveyors, so that coal may be transferred from one bucket conveyor to the other and deposited in the bunkers over either aisle, regardless of the track on which it is delivered. At the end of each aisle there is a track hopper, with a shaking feeder underneath delivering into the continuous bucket conveyor which transfers the coal to overhead 200-ton capacity steel bunkers, one for each pair of boilers, with a division at the center making two compartments. At the track end of each aisle is a large concrete ash hopper which is filled by the continuous-bucket conveyor and delivers through a chute to the railway coal cars. On the other track at the side of the boiler room is a third hopper delivering by means of a pan conveyor to the nearest continuous carrier. There is also a large ash bunker exterior to the plant. Delivery of ash is effected by a belt conveyor receiving its load from one of the cross-belts. All conveyors are motor-driven.

Depending upon the season condensate from the generating units and the Quaker Oats plant forms a varying proportion of the boiler feed. With the latter makeup water from the river is returned to the boiler room through the same pipe and is delivered to an open feed-water heater or to a large supply tank at a higher level. The condenser circulating water tunnel is a second source for makeup which is delivered to the supply tank. For boiler feeding there are one direct-acting and two turbine-driven centrifugal pumps having capacities of 450 and 600 gal. per min. The pumps are interchangeable and deliver to double feed lines, cross-connected so that either may be used to feed any particular boiler. The feed to the various boilers is controlled by hand-operated valves.

Throughout the boiler room numerous instruments are employed. For each row of four boilers there is an automatic recorder of CO_2 and draft at the uptake, with piping connections so that readings may be taken from any one boiler. Differential draft gages for each

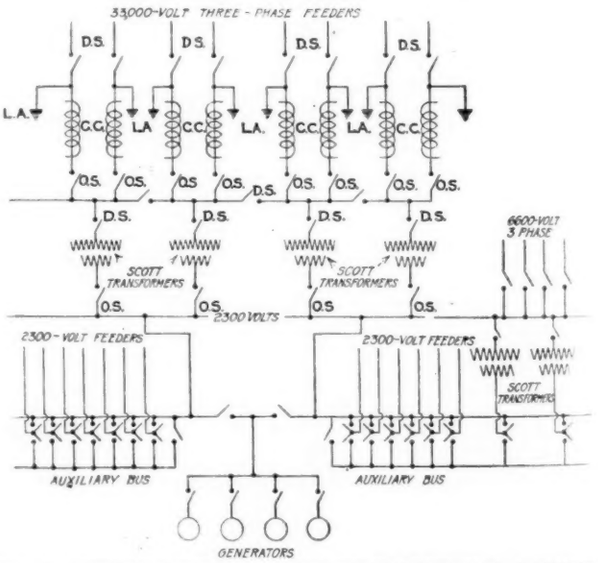


FIG. 9. SINGLE-LINE DIAGRAM OF ELECTRICAL LAYOUT

boiler show the draft over the fire and at the uptake and incidentally the drop through the setting. A U-tube attached to the gage gives the air pressure in the windbox of the stoker. A pyrometer with a 24-point switch gives temperature readings at the top of the first pass and at the uptake from 12 boilers. There are a recording pressure gage on the steam header, recording and indicating pressure gages on the steam line to the Quaker Oats plant and on the main feed line a flow meter to record all water supplied the boilers and a recording thermometer to give the temperature. The steam-heating main has indicating and recording pressure gages and on the steam-supply lines to the large

turbine and the two bleeder units, there are steam-flow meters.

In the generating room the three larger turbines have a gage panel each. Those for the bleeder turbines are duplicates containing gages giving the steam pressure at the throttle and in the first stage, a vacuum gage, a barometer and a speed indicator. The board serving the large turbine has an indicating and recording flow meter of the electrical type and an integrating wattmeter, with provisions to switch either instrument onto any one of the three machines just referred to. There are also a temperature indicator with a plug switch to give the temperature at four different points

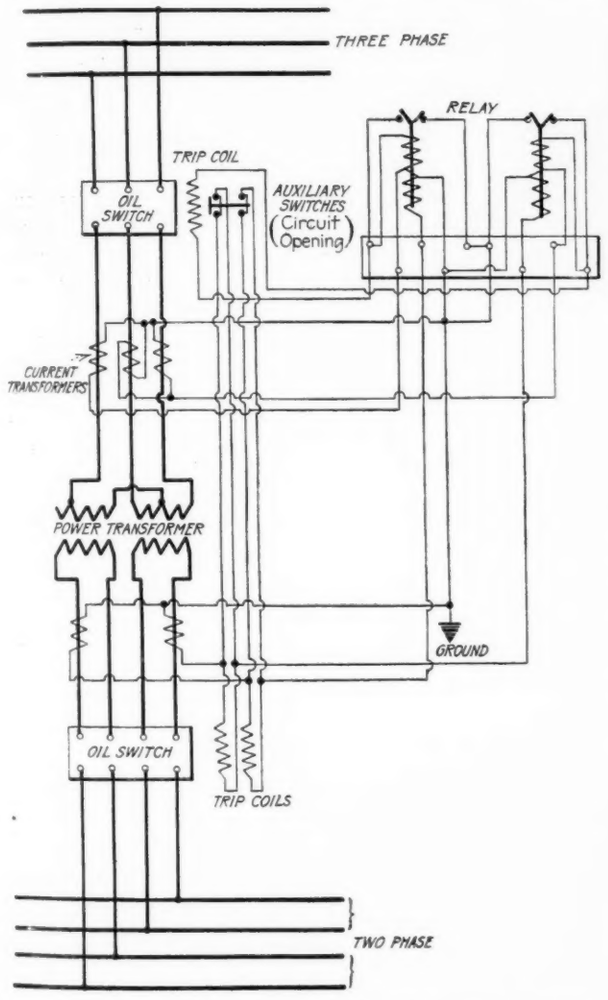


FIG. 10. WIRING DIAGRAM FOR TWO-PHASE-THREE-PHASE DIFFERENTIAL RELAYS

in the field, a mercury column for the vacuum, and recording thermometers on the throttle and the exhaust.

The electrical part of the plant is unusual in that the generation is all two-phase 2300-volt and the distribution three-phase with the exception of numerous feeders for city service. Fig. 9, a single-line diagram, will give some indication of the general arrangement of the circuits. There is a main and auxiliary bus. All 2300-volt feeder circuits are connected to the central studs of double-throw disconnecting oil switches serving as feeder switches, and may be thrown onto either bus at will. The oil switches are solenoid operated with remote control and on the feeder circuits are overload inverse time-limit relays. The feeder panels contain the usual watt-hour meters and ammeters. On the generator panels are an ammeter for each phase, a polyphase indicating wattmeter and voltmeter, a power-factor indicator, a direct-current ammeter for the field and push-button control for the motor-operated field rheostat. The bus structure is mounted on 1¼-in. iron-

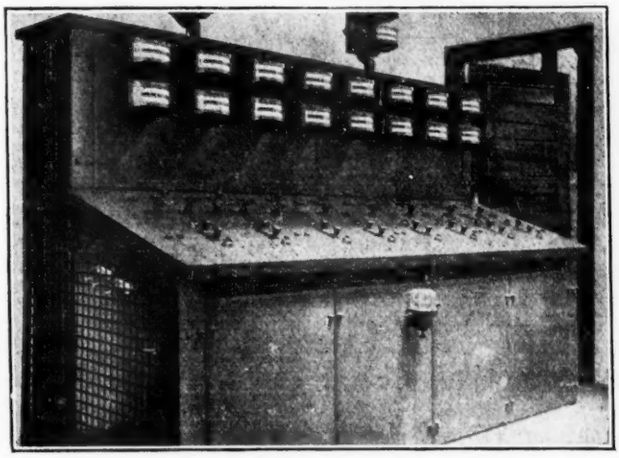


FIG. 11. BENCHBOARD IN SYSTEM OPERATOR'S ROOM

pipe framework, each bus being set in an individual compartment made up of ⅜-in. Transite board.

Out-of-town service is three-phase 33,000 volts. The current is stepped up by two sets of 600-kw. two-phase-three-phase transformers connected in multiple between the 2300-volt and the 33,000-volt busses. On the 2300-volt side are oil switches with inverse time-limit overload relays and on the high-tension side between the transformers and the bus are disconnecting switches of the air-break type.

Each high-tension feeder circuit, of which there will soon be eight, has its oil switch and inverse time-limit overload relays. The circuits are protected by

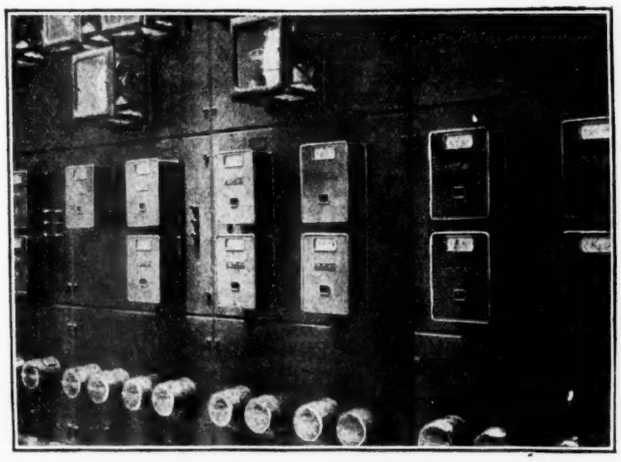


FIG. 12. METER BOARD FOR SYSTEM OPERATOR

aluminum-cell lightning arresters with the horn gaps mounted on the roof and the arrester tank inside the building. The circuits pass out through suitable roof bushings to one tower line and three pole lines. On the latter wood arm construction is used in the city and beyond the limits bow-and-arrow and wishbone crossarms.

For the National Oats Co. and other near-by customers 6600-volt service is drawn from the main bus through two banks of 1000-kv.-a. transformers operating in parallel, with switches on either side of the

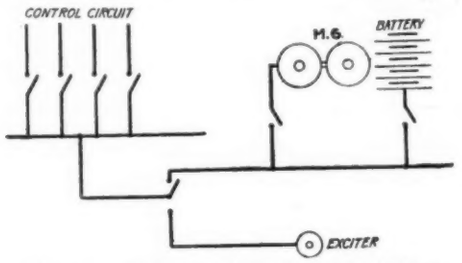


FIG. 13. THREE SOURCES OF DIRECT CURRENT FOR CONTROL CIRCUITS

transformers. Here are used the two-phase-three-phase differential reverse-current relays previously mentioned. As shown in Fig. 10 there is a current transformer in each phase on the 2300-volt side of the transformer. The high-tension side has a current transformer on each leg of the three-phase circuit. With any reversal of current or defects within the transformer the relay becomes unbalanced and through the trip coils throws out the switch on either side of the transformer.

An interesting feature of the electrical plant is the system operator's room, from which all high-tension lines are controlled. It contains a benchboard, Fig. 11, equipped with synchronizing apparatus, ammeters, voltmeters and reactive factor meters for each high-tension circuit, pull buttons for remote control of the oil switches and red and green pilot lamps to indicate their position. On the opposite side of the room is a panel board containing watt-hour meters, curve-drawing wattmeters, voltmeters, and frequency meters, and induction-type relays and testing plugs for each circuit, Fig. 12. At one end of the room is a telephone switchboard with connections to the city system, a private line to the various stations operated by the company and also affording communication with the boiler and turbine rooms. By wearing a head telephone receiver with an especially long cord the operator is able to reach the benchboard controlling the transmission lines and can look down into the turbine room through the glass front of his office. Above his desk is a map showing the transmission lines, the various generating stations and substations, the sectionalizing switches, etc. He is thus enabled to control the entire system in much the same way as a train dispatcher runs his division.

All transformers in the station are grouped in a transformer room on the main floor. They are of the oil-insulated water-cooled type. On the gallery above are all 6600-volt and 33,000-volt oil switches and the lightning arresters. Direct current for operating the oil switches may be supplied from three different sources—a 55-cell, 320-ampere-hour storage battery a 5-kw. motor-generator set used to charge the battery and the exciter bus. As shown in Fig. 13 the connections are made to each source so that the battery cannot be thrown onto the exciter bus.

PRINCIPAL EQUIPMENT OF IOWA RAILWAY AND LIGHT CO. PLANT AT CEDAR RAPIDS

	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Boilers	Water-tube	400-hp.	Generate steam	200 lb. press., 100 deg. sup.	Babcock & Wilcox Co.
6	Boilers	Water-tube	500-hp.	Generate steam	200 lb. press., 100 deg. sup.	Edge Moor Iron Co.
8	Boilers	Water-tube	627-hp.	Generate steam	200 lb. press., 100 deg. sup.	Edge Moor Iron Co.
15	Superheaters	Foster		Serve boilers	100 deg.	Power Specialty Co.
1	Superheater	B. & W.		Serve boilers	100 deg.	Babcock & Wilcox Co.
2	Stokers	Chain-grate	81-sq.ft.	Serve boilers	Motor-driven	Babcock & Wilcox Co.
6	Stokers	Chain-grate	100-sq.ft.	Serve boilers	Motor-driven	Illinois Stoker Co.
8	Stokers	Underfeed	7-retort, 94.5 sq.ft.	Serve boilers	Engine-driven	American Engineering Co.
4	Stacks	Concrete	210 x 10-ft.	Serve boilers		General Concrete Construc. Co.
3	Fans	Multivane	26,000-cu.ft. per m.	Forced draft	Engine-driven, pressure reg.	B. F. Sturtevant Co.
2	Fans	Multiblade	21,000-cu.ft. per m.	Forced draft	Engine-driven, pressure reg.	American Blower Co.
1	Pump	Outside-packed plngr	14 x 10 x 12-in.	Boiler feed	200 lb. steam, 220 water press.	Canton-Hughes Pump Co.
1	Pump	Centrifugal	5-in., 600-g.p.m.	Boiler feed	Dr. by Westinghouse turbine	Worthington Pump & Mach. Cor.
1	Pump	Centrifugal	4-in., 450-g.p.m.	Boiler feed	Dr. by Terry turbine	Worthington Pump & Mach. Cor.
1	Pump	Duplex	14 x 10 x 12-in.	House service		Canton-Hughes Pump Co.
1	Pump	Centrifugal	4-in.	House service	Motor-driven	Worthington Pump & Mach.Cor.
2	Conveyors	Cont.-bucket	24 x 24-in.	Coal and ash handling	Motor-driven	Link-Belt Co.
3	Conveyors	Belt	24-in.	Coal and ash	Motor-driven	Jeffrey Mfg. Co.
1	Conveyor	Pan	30-in.	Track hopper to bucket conv.	Belt-driven	Link-Belt Co.
1	Heater	Open	5,000-hp.	Heat feed water		Harrison Safety Boiler Works
1	Turbo-generator	Reaction	7,500-kw.	Main generating unit	2-ph.,60-cy.,2300 v.,1800-r.p.m.	Allis-Chalmers Mfg. Co.
1	Condenser	Surface	13,000-sq.ft.	Serves 7,500-kw. turbine		Westinghouse Elec. & Mfg. Co.
1	Pump	Comb. air and cond.	6-in.	Serves 7,500-kw. turbine	Dr. by 50-hp. Westinghouse tur.	Westinghouse Leblanc
1	Pump	Centrifugal	15,000-g.p.m.	Serves 7,500-kw. turbine	Dr. by 100-hp. Westinghouse motor	Westinghouse Elec & Mfg. Co.
2	Turbines	Bleeder-type	3,500-kw.	Main generating units	2-ph.,60-cy.,2300-v.,1800-r.p.m.	Westinghouse Elec. & Mfg. Co.
2	Condensers	Surface	10,500-sq.ft.	Serve bleeder turbines		Wheeler Cond. & Engine Co.
2	Pumps	Wet-vacuum	10 x 26 x 14-in.	Serve bleeder turbine units	Engine-driven, 95 r.p.m.	Wheeler Cond. & Engine Co.
1	Pump	Centrifugal	200-g.p.m.	Condensate pump	Dr. by 2-hp. Allis-Chalmers motor	Goulds Mfg. Co.
1	Pump	Centrifugal	No. 4	Condensate pump	Dr. by 7½-hp. Allis-Chalmers motor	C. H. Wheeler Mfg. Co.
1	Turbo-generator	Reaction	1,500-kw.	Main generating unit	2-ph.,60-cy.,2300-v.,1800-r.p.m.	Allis-Chalmers Mfg. Co.
1	Condenser	Surface	5,000-sq.ft.	Serves 1,500-kw. turbine		Wm. Baragwanath & Son.
1	Pump	Centrifugal	2,500-g.p.m.	Condenser cooling water	Dr. by Westinghouse 30-hp. motor	Kingsford Foundry & Mach. Co.
1	Pump	Reciprocating	8 x 16 x 20-in.	Dry air pump		Union Steam Pump Co.
1	Pump	Centrifugal	3-in.	Condensate pump	Dr. by 10-hp. Allis-Chalmers motor	Kingsford Foundry & Mach. Co.
1	Exciter	Engine-driven	100-kw.	Excitation main units	Dr. by Ball engine	General Electric Co.
1	Exciter	Motor-driven	75-kw.	Excitation main units	Dr. by 100-hp. Westinghouse motor	General Electric Co.
1	Exciter	Turbine geared	150-kw.	Excitation main units	Ratio 7200-900 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Motor-generator		1,500-kw.	Railway service	600 v., 600-r.p.m., 2,160-hp. syn. motor	Westinghouse Elec. & Mfg. Co.
1	Motor-generator		500-kw.	Railway service	600-v., 720-r.p.m., 700-hp. syn. motor	General Electric Co.
1	Motor-generator		100-kw.	Commercial service	550-v., 514-r.p.m., Dr. by syn. motor	Westinghose Elec. & Mfg. Co.
1	Crane	Traveling	50-ton	Serves engine room		Whiting Foundry Equip. Co.

Vulcan rotating soot blowers and Bayer hollow stay-bolt blowers; Crane high-pressure steam valves; Crane straightway water valves; Feed valves, Crane Hancock and Lunkenheimer; Stop valves, Crane and Golden-Anderson; Blow-off valves, Edwards, Simplex and Homestead; Mason regulators on fan engines; Fisher governors on pumps; Hays CO_2 recorders; Ellison draft gages; Tycos pyrometers and recording thermometers; G. E. and Republic flow meters; Bristol recording and indicating pressure gages; Ashcroft vacuum gages; H. & M. mercury column; G. E. speed indicator on turbines; Short & Mason barometers; G. E. temperature indicator for field of 7,500-kw. generator; G. E. switchboard and electrical instruments.

For railway 600-volt direct-current service there are two motor-generator sets, one rated at 1500-kw. and the other at 500-kw. To serve the small direct-current power load there is also a 100-kw. commercial set. On the direct-current switchboard arrangements have been made to throw the two railway motor-generator sets in series, so that current at 1200 volts may be supplied to outlying towns and at the same time 600-volt service to the company's system in Cedar Rapids.

Electrical energy for the Quaker Oats plant is supplied through four two-phase 2300-volt feeder circuits connected to the main bus through 1000-ampere oil switches with inverse time limit relays. The service is carried through underground conduits by 850,000-cm. double-conductor concentric cables, lead-covered and varnish-cambric insulated. At the Quaker Oats substation the circuits feed through oil switches to a 2300-volt bus, protection at this end being afforded by dynameter-type reverse power relays with tripping reactors. From the bus, transformation to three-phase 240-volt current is effected through two banks of 3000-kv.-a. transformers operating in parallel. From each bank of transformers low-tension busses run back to opposing ends of the customers' switchboard. Each bus contains four pieces of copper 10 in. wide by ¼ in. thick, and back of the board they continue from each end so that each phase is made up of two such busses connected in parallel. In these busses from the low-tension sides of the transformers there are 22,500 lb. of copper.

The substation is reported to be the largest low-voltage alternating-current installation in the country and a similar claim is made for the two circuit-breakers on the switchboard. They are rated at 240 volts, 12,000 amperes, are hand-operated and provided with shunt trips and laminated studs.

F. W. Laas is chief engineer of the station and J. M Drabelle electrical engineer for the company.

Thomas Elliptic Shaking and Dumping Grate Bar

One of the disadvantages of a fixed furnace grate is that at certain periods the fire must be burned down and the clinkers and ashes pulled out on the fireroom floor. With the shaking and dumping types of grates the operation of cleaning is simplified in that the clinkers are dumped into the ashpit, a much more simple and cleanly method than the other.

A design of shaking and dumping grate bar that is of interest is manufactured by the Thomas Grate Bar Co., Birmingham, Ala., and is shown in Fig. 1. This grate is, from end view, elliptical in form and is made up of a curved top and bottom face joined together with spacing and connecting lugs of one-third contact and two-thirds air space, as shown in Fig. 2. This provides a structure in which the heat cannot equalize, and the under portion of the bar does not get overheated. A bottom and end view of the bar is shown in Fig. 3.

The elliptic shape of the grate bar gives an eccentric movement when it is operated, and therefore the bar slips under the fuel bed without disturbing it more than gently raising and lowering, and thus moves the ashes from their lodgment, and with the dumping operation deposits them into the ashpit. During the shaking movement of the grate the ash is collected in the troughs between the bars, because the space between the bars is not increased with the shaking movement. With a little longer stroke of the shaking lever the movement may be extended so that any size opening between the bars can be had that is necessary to deposit the refuse into the ashpit. This is accomplished without breaking up the fuel bed, because the grate bars contain no sharp edges to break the bed or tear up the fuel into holes and pockets. Neither is there a flat surface for the ash to ride upon and collect.

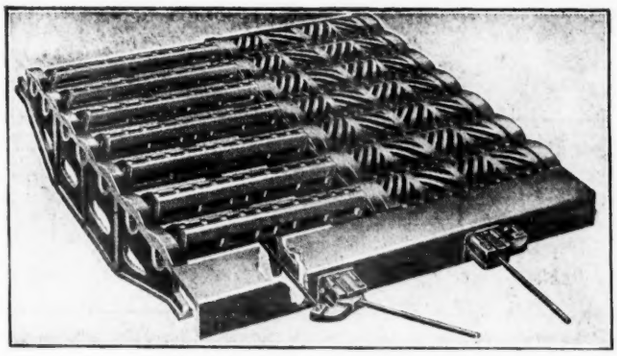


FIG. 1. THOMAS GRATE BARS IN DUMPING AND RUNNING POSITION

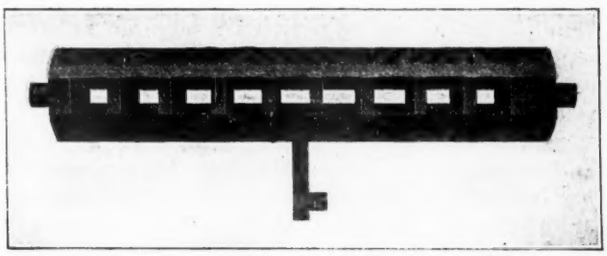


FIG. 2. SHOWING AIR SPACE

When cleaning, the fires are burned down and the refuse is dumped into the ashpit by giving the lever a full stroke, which throws the bars at an angle of 85 deg. with a 3½-in. space between the bars, and the funnel shape thus formed hinders any large portion from lodging between the bars and so preventing their going back into their proper position. On account of the peculiar shape of the grates the large clinkers will be thrown back on top of the bars to be hooked out of the door if they cannot go through the openings when dumping.

FIG. 3. BOTTOM AND END VIEW OF THE GRATE

Conditions in the Power Industry

By L. W. SCHMIDT

A digest of the reports of United States consuls on the power situation in various parts of the world and the influence of the war upon this important industry. Also see "Power," June 25, 1918.

ONE of the chief effects of the war on the economic life of England has been the enormous increase in the demand for electrical power. Electrical associations and power companies, at recent meetings, have discussed the question of how it will be possible to meet this demand under the existing difficult conditions. The average power supply of England is one horsepower for each five inhabitants, but this average is far exceeded in most of the manufacturing districts. In Lancashire, for instance, it has been as much as five horsepower for eight inhabitants. It is now estimated that the Lancashire district alone will need at least 2,000,000,000 units per annum for industrial purposes and that the total requirements, including railroads and domestic uses, may run to 5,000,000,000 in the near future (C.R.164).[1] It is, therefore, no wonder that all the leading power stations of England continue to be extremely busy.

Both industrial and public consumption are large and the tramways are using their facilities to capacity. The Nottingham Tramway Committee, for instance, reports to the city council (C.R.156) for the year ended March, 1918, total receipts amounting to $1,194,335, an increase of $178,560 over the year before. The operating expenses, which were $777,420, show an increase of $88,835. On the other hand, there is a decrease in the cost of maintenance. The tramway system had in service an average of 119 cars a day, which is three more than during 1917, and carried 52,690,881 passengers, or 5,209,947 more than in 1917. Nearly four-fifths of all the passengers were carried at the ordinary rate of two cents; this, however, was increased to three cents owing to the increasing cost of operation.

Power Generation in Nottingham

Like nearly all other cities in England, Nottingham suffered from lack of coal. Great care, therefore, was taken in the use of coal for power generation, and as a result it was possible to produce 216,174 additional units with an expenditure of 700 tons of coal less than during the preceding year. Nevertheless, the coal bill showed an increase of $24,380, which, with the greater outlay for wages, prevented the undertaking from making a profit.

With a view to saving coal, steps had been taken shortly after the outbreak of the war to lessen the consumption of gas. The result has been that during the year of the report only 3,690,000 cu.ft. of gas was sold for public lighting as compared with 102,000,000 cu.ft. a year before the war. The present consumption of gas is still more than 6,000,000 cu.ft. below the normal annual consumption.

The Glasgow corporation, the report of which as a rule is regarded as a safe index of business in the English power industry, shows a record year as to earnings, which were $6,874,573 against $6,132,335 during the year before (C.R.169). Also, this undertaking reports considerable addition to its operating expenses; so the item of power shows an increase from $327,180 during 1917 to $418,607 during the present year. One of the best indications of how the war has affected the power industry of England is afforded by the power plant of Leeds (C.R.170), which is a municipal undertaking. During the year 1915 it distributed 12,000,000 units and is now selling 62,000,000. To meet this enormous demand a considerable extension of the existing plant was necessary, which was carried out since the war began. It is contemplated to provide for a demand of at least 60,000 hp. and during the last four years $1,250,000 has been expended on improvements alone. It is now intended to spend another $580,000 for generating machinery and an extension of the boiler house. High wages and cost of materials have added largely to the running expenses of the Leeds power undertaking, which also operates the local tramways.

England Expects Many New Uses for Electrical Power After the War

England will make more use of electrical power for street-railway purposes in the future than it has done. Among the schemes in preparation is one dealing with a tramway from Edinburgh over the Forth Bridge, which will be 11½ miles long (C.R.137X). Additional power also will be required to supply energy to the ever-increasing number of electric vehicles. The electric vehicle section of the Incorporated Municipal Electrical Association has had this matter under consideration and has come to the conclusion that "the knowledge that in actual commercial service the electric vehicle provides the cheapest means of transporting a given weight of goods a given distance in urban transport and delivery duty is diffusing far and wide in commercial circles, the proof of this being the increasing number of inquiries the committee is receiving as to how and where such vehicles can be obtained."

Increasing use will be made of electrical power for farm purposes. A new set of experiments in crop electrification was carried out at Liverpool on an area of one acre, which was divided into several plots and sown with wheat, barley and several vegetables. Near by but sufficiently removed so as not to be influenced by the electric treatment another area was planted in the same way and manured with a patent manure. "The general method of applying the electrical treatment consisted of the use of a series of fine wires suspended from poles on either side of the electrical area. Much care was given to the insulation, which was triple in character, consisting, in the case of the principal insulators, of long glass rods to the ends of which the live wires were attached. A high-tension current was discharged through the air to the plants, and thence to the soil below. The supply of electricity was obtained from the ordinary city mains and then trans-

[1] C. R. indicates "Commerce Reports" of 1918.

formed into high-tension current." The results showed an increase in production in the case of nearly all the cereals and vegetables grown. In the case of onions it reached 633 per cent.; the straw of the barley was 18 per cent. below; barley was 30 per cent. above, and oats 39 per cent. This is a confirmation of the results of other experiments made with electrical cultivation in other parts of England, and a larger use will probably be made of it in the near future. More progress has been made in England during the last year in the employment of electric power for driving general farm machinery.

France Has Important Hydro-Electric Center in the Toulouse Region

A great part of the funds now accumulated by France to be used in the rehabilitation of that country after the war will be spent for the development of its large hydro-electric powers. One of the best fields for hydro-electric development in France is the Toulouse region. In Toulouse is found the oldest hydro-electric enterprise of France, which was put into operation during the year 1888. The principal power plants in that district belong to the Société Hydro-Electrique Roussillonnaise which covers with its transmission lines a territory of 62 miles and serves a population of 100,000. The Société Ecoiffier owns 105 miles of transmission lines, and the Compagnie des Chemin de Fer du Midi has a large 6000-hp. plant and five substations.

The hydro-electric possibilities in this neighborhood are extremely numerous. The basin of the Bouillouse, for instance, can store 6,000,000,000 gal. of water, and in the upper valley of the Aude 200 communes are at present supplied with electric light and power from hydro-electric sources. The operating company is the Société Méridionale de Transport de Force. In the Department of the Ariège at Las Rives is the power plant of the Société Métallurgique and at Auzat the 20,000-hp. plant of the Société des Produits Electro-Chimiques des Pyrénées. Many others of the industrial enterprises existing in this region also have private hydro-electric power plants. The Société Pyrénéenne d'Energie Electrique has its field of operation in the plain of Languedoc and Gascony. This undertaking, which is the most powerful of the district, owns a great number of waterfalls and is extending by buying adjoining stations. Its competitor is the Société Toulousaine d'Electricité with installations in Bazacle, Mancioux and Pont-du-Roi. New dams at present are under construction near Tanus on the Viaur, at Truel on the Tarn, and on the Truyère. All in all it is estimated that this district has available at least 200,000 hp., of which only 40 per cent. is now developed (C.R.146).

Progress in National Power Control in Scandinavian Countries

Having once decided on a vigorous program for the expansion of the national power industry the Norwegian government has now settled down to its execution. The first step has been the appropriation by the government of $4,000,000 for the purchase of the Glomfjord power plant in the province of Nordland. This plant draws its power from a series of lakes in the neighborhood of Svartisen and it is estimated that after the completion of the scheme there will be available between 80,000 and 90,000 hp. (C.R.136). This will be followed soon by other purchases, one of which will be the acquisition of the Sulitjelma iron mine. This transaction appears to appeal to the advisers of the Norwegian government because it unites the advantages of adding to the governmental property a large water power which can be developed with good prospects. So far no definite arrangements have been made with the present owners of the property (C.R. 162).

Centralizing Power Control in Sweden

In Sweden steps are being taken to centralize power control in the interest of the nation. An organization is under formation the purpose of which will be to advocate the better use of the natural-power resources of the country. This organization will advise local associations on the distribution of power and assist financially in the execution of approved schemes. Preference will be given, if possible, to local coöperative organizations and the development of small local powers. A coöperative power plant is contemplated in the Province of Halland, where an association of farmers has acquired property rights in the Skedala waterfall. The cost of the undertaking is estimated at $134,000. The Trollhattan power station has just made arrangements to supply a coöperative association of power users in Hisingen. An agreement has been made between the parish of Vastra Frolunda and the Yngeredsfors Kraftaktiebolag to supply the whole parish with power and light at an inclusive charge which will be collected pro rata from the parishioners. In addition to this increasing consumption of power for general purposes there is a steadily growing demand for industrial power from big consumers. The electrochemical industry, which is firmly established in the Scandinavian countries, finds in this respect a new competitor in the electro-metallurgical industry. Only recently it was reported that the Aktiebolag Porjus Smältverks have added two new electric smelting ovens to the three already in operation. The company's power comes from the Porjus waterfalls (C.R.169). Forced by the growing demand of the national power industry and the increasing difficulty of obtaining foreign cable, Norway has started now its own cable industry. The result so far is promising and $402,000 has been spent in the buildings, machinery, etc., of the new plant, which is located at Christiania (C.R.148).

Renewed Interest in Scandinavian Power Coöperation

The project of power transmission from Norway to Denmark is receiving new attention in Denmark owing to the increasing difficulties of providing that country with coal from Germany. It appears that there are difficulties as to the sources of the power needed for transmission to Denmark. Eastern Norway is poor in large natural-power sources, and any power to be transmitted to the continent, therefore, would have to come from Western Norway, where the Sorland district forms a good basis for a supply to Jutland by way of cables laid through the Skagerrack. Most of the inlands, however, would have to draw their power from Sweden. Denmark, of course, is very much interested in the outcome of this discussion, as that country could make use of 200,000 hp. for industrial purposes alone. A

question that is not fully cleared so far is whether under normal circumstances it will not be cheaper to produce the needed power with the help of steam generation in Denmark instead of going to the heavy expense of transmission by submarine cable.

A hydro-electric development of considerable magnitude is planned by an Icelandic company, financed principally by Norwegian interests in Iceland. This scheme contemplates the development of over one million horsepower from the River Fjorsaavasdraget in Iceland. The necessary river property has been acquired by the company and surveys have been made on the basis of which it is proposed to build six power houses capable of producing 697,000 hp. during low water and 1,114,000 hp. during high water. The execution of the scheme seems to offer many difficulties owing to the great distance of the power house from the coast and the lack of railroads. Before the work can be started it will be necessary to build a railroad, the first in the island. Material for the farthest inland power station will have to be transported over a distance of 40 miles.

Hydro-Electric Enterprise in Switzerland

Vice Consul John T. McCutcheon in Lausanne remarks at length on the extensive hydro-electric developments of the canton of Vaud in Switzerland (C.R.167). This canton holds a number of prosperous cities, including Lausanne, and draws its power entirely from hydro-electric stations. The principal sources of this power are found in the Joux and the Rhone valleys. The powers of the Joux valley are developed by the Forces de Joux, a company in which the state is the majority stockholder. The Forces de Rhone, which is the company operating the power plant in the Rhone valley, is owned by the City of Lausanne. Both companies are worked for the public benefit only and are not supposed to make extensive profits. They have by their existence given a great impetus to local industries, especially as rate reductions are allowed to artisan users, sawmills and other consumers taking power only in small quantities.

The effect of the war on water-power development in Italy so far has been extremely beneficial. At the end of 1916, 1,060,000 hp. was developed in Italy, and during December, 1917, there were under examination requests for concessions for another 816,147 hp. to be developed as early as possible. Most of the concessions are situated in the provinces of Lombardy, Piedmont, Umbria and Calabria.

Little news of importance has come recently from South America. Argentine, according to its last census, which is now five years old, had 305 power stations with an invested capital of $127,875,724, employing 9916 men. Mention should also be made of Philip S. Smith's excellent report on electrical goods in Ecuador and Peru (Special Agent Series 154) which contains a complete list of all the important central stations in Peru.

China Buys American Power Machinery

China has been an excellent customer for American power machinery during the last years. A new 20,000-kw. turbo-alternator, costing $457,450, for the electrical plant in the International Settlement in Shanghai, was recently ordered in America. Other electrical equipment, which in former years was nearly always supplied by English firms, this time was bought from America. The value of the whole order is estimated at $1,500,000 by Consul General Thomas Sammons (S.C.R.52e).[2]

The Government of Madras, India, has approved the proposal of its chief electrical engineer for the development of the water powers of the Scriveni River at a cost of approximately $1,329,777 to supply the cities of Coimbatore and Podanur (C.R.139).

Electric Power in New Zealand

The use of electric power has made rapid progress in New Zealand, supported by the liberal policy of the government. While during 1911 only 1084 electrical installations were in existence, 2516 were reported during 1916 (C.R.146). According to a report in the New Zealand *Capital and Labor Review*, that country has 3,500,000 hp. of undeveloped water power. Consul General Alfred A. Winslow says in his annual report (S.C.R.61a) that the Lake Coleridge development has been able to supply the city of Christchurch during the year 1917 with 6,000,000 units as compared with 3,000,000 the year before. "Additional hydro-electric plants will be installed by the government following the close of the war, and a strong company has been formed to make use of a large amount of this power in the manufacture of different products, principally nitrate and carbide, both of which are extensively used in New Zealand and Australia. It is proposed to open two or three plants in North Island and to connect them up with a trunk line from Auckland and Wellington, so as to supply both cities and all the near-by towns and cities along the line. Additional sites will be developed later as required to supply the demand. It is estimated that 500,000 or 600,000 hp. could be developed for such a purpose at a comparatively reasonable cost."

Pipe Stoppages in New Heating Systems

A frequent and often puzzling difficulty met with in putting a new heating system in operation is stoppage in the piping or valves. It is not to be inferred that the fault is always the result of "boneheaded" carelessness on the part of someone. Usually the most annoying and difficult situations arise from a "progressive" stoppage; that is, one that "gets no better gradually." Of course, when a new job is put in, it is tested out and if some fellow has left a wad of waste inside of a pipe that completely stops the flow, it is simply a matter of disconnecting and finding it. But if the job tests out all right at first and gradually one or more of the radiators do not heat quite as well as they should and finally on some cold day that radiator or section of the system becomes as cold as proverbial charity, it is likely to be a case of sediment accumulating gradually at some point where the circulation is not rapid. The cause of such a stoppage is cumulative; there may have been some core sand left inside of the radiator sections, some loosened rust or mill scale inside of the pipe, or other foreign matter from various sources. Such stuff can usually be gotten rid of easily if not combined with some sticky substance to form it into a mass. Sometimes there has been too much "dope"

[2] S. C. R. indicates "Supplement, Commerce Reports."

used on the slip nipples in assembling the radiator sections and on the pipe threads in making joints, especially if the "dope" is put inside of the fitting or opening and is pushed in ahead of the pipe. This material is more or less sticky as a rule and on coming in contact with the core sand, or the like, forms a heavy, sticky mass that is almost impossible to get rid of by blowing out.

In some cases this condition is so bad that a tee fitting has to be put at the bottom of each riser through which to insert a cleanout tool or jointed rod up the riser to reach and free the stoppage. Such a procedure calls for a valve between the main supply and the riser or shutting off all the steam from the system, and also considerable headroom in the basement to manipulate the cleaning rods—a bad job at best.

Prevention is the surest remedy, and while the apparent negligence on the part of the manufacturer in not having the radiators thoroughly cleared of sand is beyond the control of the engineer, he should see to it that no fault of himself or of his crew adds to the risk of stoppage, by the use of too much "dope" in making pipe joints. "Enough is plenty" and a little is enough.

Multiwhirl Oil Cooler

During the last ten years the number of steam turbines installed in power plants has increased rapidly, necessitating the solving of various problems, among others that of cooling the lubricating oil used in the turbine bearings, reduction gear, etc. It is evident to every engineer that it is necessary to cool this lubricating oil so that it can be used over and over and the proper temperature maintained.

Among the various devices that have been produced for this purpose is the multiwhirl oil cooler, manufactured by the Griscom-Russell Co., 90 West St., New York City.

As shown in Fig. 1, the shell is cylindrical and is made of cast iron. The water head is of cast iron or composition, the floating head is of composition, and the tube plates are of steel. The copper, seamless-drawn tubes are expanded into a fixed tube plate at one end and into a floating head at the other without the use of glands or packing. The floating-head construction permits of the expansion and contraction of the tubes without strain on the joints. As shown in Fig. 2, as well as in Fig. 1, the tubes are arranged in what might be termed a bundle with the baffle surrounding a center piece, so as to make a spiral or helical baffle. This baffle is made of sheet iron or brass perforated to permit the insertion of the copper tubes which constitute the cooling surface. Spacer rods are located near the outer circumference of the baffles in order to secure them rigidly and also to maintain an equal cross-section of flow of the oil through the length of the spiral.

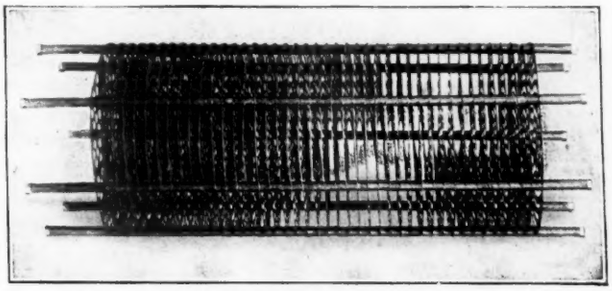


FIG. 2. HELICAL BAFFLE AND SPACER RODS

The lubricating oil is circulated through the cooler by means of a pump, flows through the shell and is brought into contact with the tube surface by means of the helical baffle. By reason of this construction the oil-pressure drop is a minimum as the helical baffle guides the oil in its flow without retarding its progress to any appreciable extent. It will be seen that the oil will strike the cooler tube substantially at right angles, and the relatively high velocity of the whirling body of oil scours not only the tube surfaces, but also the shell, thereby tending to keep the interior of the cooler clean. Furthermore, there are no dead pockets in which dirt can accumulate. The cooling water passes through the tubes, which are usually arranged in two or more passes.

In case it is necessary to remove the tube bundle and baffle, it can be done without breaking any oil connection by removing one head and pulling the bundle out of the shell. This can be easily done as all pipe connections are made directly to the shell itself. By removing the cover plate on the floating head, shown at the left of Fig. 1, access may be gained to the tube's interior without disturbing any other part of the cooler or its connections.

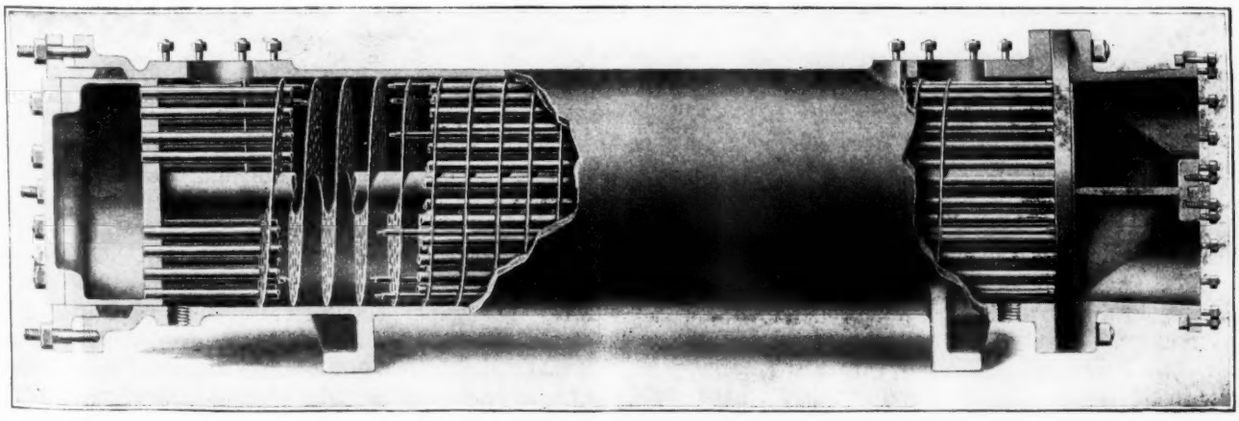


FIG. 1. MULTIWHIRL COOLER, OUTSIDE-PACKED-HEAD TYPE

Something About Boiler Testing

Willis tells Engineer Beards how to run a boiler test and proceeds to show him how the various values are obtained, taking item by item and using assumed values as a basis for the test.

"WILLIS," said Joe Beards, as the former stepped into his engine room one Saturday afternoon on his way home, "the last time you were here you said something about running a boiler test. That has been with me ever since and now, seeing that these old kettles of mine are doing better work than they used to, I have got a hankering to run a test to see how much water is being evaporated from each pound of coal that is burned in the furnace.

"Hold on a minute before you begin," went on Joe, as Willis started to speak. "Just let me explain what I want. I don't want one of these highbrow tests, in which the boilers have been put in the pink of condition or where picked coal is used or where the firemen have been tipped off that if they do their best there will be an extra dollar in it for them. What I want is an everyday-run test, with the combination of boilers, coal and firemen the same as we have every day we run. Then we will know just how far short we are from the best the plant can get with trained firemen, clean boilers and high-grade coal."

"Your idea is a good one, Joe," said Willis, when he got a chance to talk. "A test under your ordinary operating conditions will show you just how near average practice you are getting, and it is not so hard to run a test as you may think. Of course, certain conditions will have to be maintained and certain apparatus will be required. As you want to find out what your boilers are doing under existing conditions, there will be no need of cleaning the boilers of scale or soot other than has been your regular practice, but there is one thing you want to attend to and this is the blowoff valve. If it is leaking the least particle, it should be made tight or the pipe blanked, so as to prevent all leak of water from the boiler, which would indicate a greater evaporation than you were actually getting."

"That is easy if that is all there is to it," said Joe.

"But that is not all there is to it," rejoined Willis. "You will have to rig up a reliable method of weighing the water you feed to the boilers. That is best done by using three barrels and a small platform scale. Two of the barrels are placed on a platform (Fig. 1) and each is piped with an overflow at the top so that the water can never get above a certain height. Each of these two barrels is also fitted with a discharge pipe close to the boiler. Before they are placed on the platform they are accurately weighed on the scale when filled with water up to the overflow pipe and again when the water is on a level with the discharge pipe. The difference between these two weights is the weight of water in the barrel that is to be recorded on the water-log sheet each time a barrel is emptied. The third barrel receives the water from the two on the platform when filled to the overflow pipes, and from it the boiler-feed pump gets its water."

"What are you going to do in case one of the platform barrels holds more water than the other?" asked Joe.

"The best way is to number each one and make a note of the weight of water in pounds each barrel holds when calibrated. For instance, suppose No. 1 barrel will hold water weighing 466 lb. when the water is between the level of the discharge and the overflow pipe, and that No. 2 barrel holds 491 lb. It is only necessary to place these weights in the log column representing No. 1 and No. 2 barrels and mark in each column the number of times each barrel is emptied into the third one. One way is to make a chalk mark on the barrel each time it is emptied. The number of chalk marks times the weight of water in the barrel for each filling

FIG. 1. ARRANGEMENT FOR WEIGHING FEED WATER

will be the total weight of water passed through that particular barrel. The sum of the total weights of water from both barrels is the total weight of water discharged into No. 3 barrel.

"Having arranged your barrels, you will require a good thermometer for submerging in No. 3 barrel in order to take the temperature of the feed water at that point. The same platform scales that were used for weighing the barrels of water can be used for weighing the coal and ashes. Of course, the weight of the wooden platform on this scale (Fig. 2) and that of the wheelbarrow must be balanced on the scale so that the coal weight can be taken direct and not have to be obtained by deducting the weight of the wheelbarrow and platform each time a barrow of coal is weighed, which, by the way, should be the same each time. This coal is to be dumped on the boiler-room floor as needed.

"Then a thermometer graduated to about 700 deg. F. will be wanted to stick through a hole at the nearest point where the gases leave the boiler-heating surface.

If you do not want to make too many holes in the uptake, the thermometer can be removed and one end of a U-draft gage connection can be put in the same hole for reading the draft. A good way to do that is to connect the draft gage to one end of a rubber tube, the

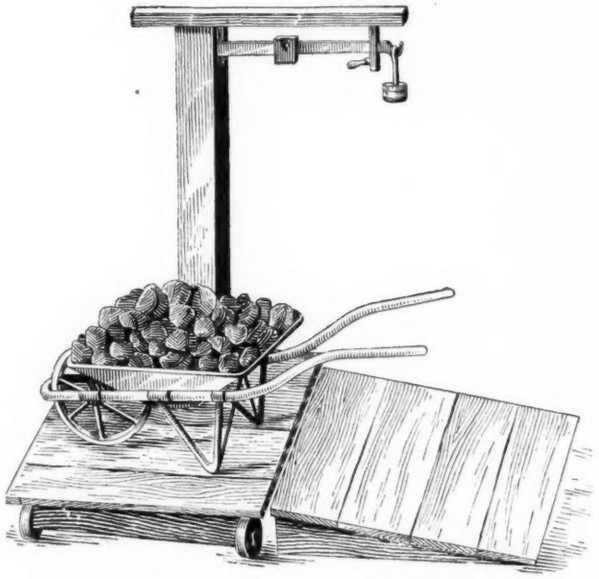


FIG. 2. SCALE AND PLATFORM FOR WEIGHING COAL

other end of which is connected to a short piece of small pipe which is to be placed in the hole."

"If we don't have to get any more apparatus than you have mentioned, I figure I will be able to run a test," commented Joe; "but go light on instruments that cost much money, or it's all off, because the company won't stand for much highbrow stuff, as they call it."

"If you get what apparatus I have mentioned, the rest is up to you," answered Willis. "When you run the test, start it just after the fires have been cleaned and run it for at least ten hours. Another thing; at the moment of starting the test tie a string around the water-gage glass at the water level and don't blow down the water column for at least an hour before the start. When the test is finished the water must be brought back to the same level as at the start."

"It seems to me there is something about moisture in coal that has to be figured," said Joe. "How do you do that?"

"That's easy. During the test you must take a small sample from each load of coal brought into the boiler room. It is best to keep these samples in a cool place and in a box having a cover. When the coal samples have been taken, mix them up, pulverize the lump and thoroughly mix all together again. Then the total quantity is divided into four equal parts; taking one of them, the coal is again crushed and mixed. This quartering of the selected samples is carried on until the samples have been reduced to about five pounds. This sample is placed in a glass jar and is used to determine the calorific value in B.t.u.

"But that is not all," continued Willis. "When the main sample has been reduced to about 100 lb. about 15 lb. should be immediately placed in a shallow pan and dried for not less than twelve hours; longer is better. This sample is the one that is weighed both before and after drying, on scales with readings at least to quarter ounces. The difference between the weight of the wet and the dry sample is the moisture in the coal.

"One thing more. The ashpit must be cleaned at the beginning of the test so that the ashes made during the test can be collected for weighing in a dry state to determine the percentage of ash in the coal burned during the test."

"Gee! Willis, this boiler testing is going to be some job. Is there much more to take care of?"

"Sure thing," answered Willis. "During the test you will have to take readings of a number of items and then record them on a record sheet. These readings will be of the weights of coal and water, feed-water temperatures, steam pressure and the temperature of the flue gases. Then you will total the figures under each heading and divide this total by the number of readings to get an average. This applies to all items, except coal and water, which you will want in total weight. It is from these totals and averages that the boiler performance is calculated."

"What you have told me can easily be done, but when you say calculate you have got through my barbed-wire defense and broken my line of communication. How are the calculations made?" asked Joe.

"Perhaps we can suppose a case and work the thing out right here, but the figures we use will have to be assumed. We will take one of your boilers, which are 150-hp. capacity and are hand-fired with natural drafts and each has a 6 x 6-ft. grate or 36 sq.ft. Suppose that the water evaporated during the test is 30,300 lb. and that 3916 lb. of coal is burned, the average steam pressure is 150 lb., the feed-water temperature is 166 deg. F. and the flue-gas temperature is 480 deg. F.

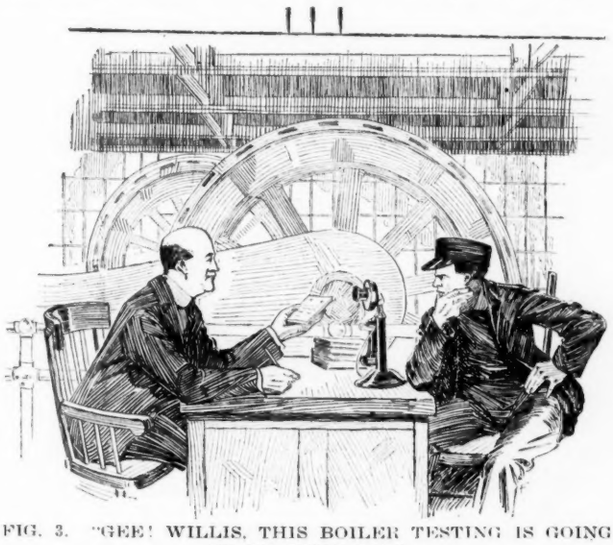


FIG. 3. "GEE! WILLIS, THIS BOILER TESTING IS GOING TO BE SOME JOB"

"It will be a good idea to make a table of our assumed test and see just how the thing is figured out, numbering each item consecutively. The first seven items are fixed; the average steam pressure is obtained by adding the several readings together and dividing the sum by the number of readings. We will say that the average steam pressure is 150 lb. The temperature of the feed water is obtained in the same way, as is also that of the escaping flue gases. These we will put down as 166 and 480 deg. respectively. The moisture

in the steam is 2 per cent. we will assume. The total coal burned during the test will be, as we have said, 3916 lb., and it contains 4.5 per cent. moisture Then 3916 × 0.045 = 176, and 3916 — 176 = 3740 lb. of dry coal burned during the ten hours' run. The ashes. we will say, weigh 262 lb. for the run, or 262 ÷ 3740 = 0.07, or 7 per cent. As 30,300 lb. of water is evaporated and the steam contains 2 per cent. moisture, we have 30,300 — (30,300 × 0.02) = 29,694 lb. of steam, corrected for moisture. The dry coal burned per hour per square foot of grate area is one-tenth of the total dry coal burned, divided by the grate area, or 3740 ÷ 10 = 374; 374 ÷ 36 = 10.39 lb. of coal per square foot of grate area per hour.

"With 30,300 lb. of water raised from 160 deg. F. and transformed into steam of 150 lb. gage pressure, with a total of 3916 lb. of coal, of course there would be 30,300 ÷ 3916 = 7.74 lb. of water evaporated per pound of coal as fired. But that is not the actual evaporation from and at 212; in fact, it is less. Now it takes 970.4 B.t.u. to transform one pound of water from 112 deg. F. into steam at 212 deg. F."

"That's what always gets my goat—this from and at 212 deg. F. What's it all about?"

"It means that the water is being transformed from a liquid state at a temperature of 212 deg. F. to steam or a vapor at a temperature of 212 deg. F. Now get out your table of the properties of steam and you will find that the heat in one pound of water at 166 deg. F. is 133.86 B.t.u. and the total heat in one pound of steam at 150 lb. pressure, gage, is 1195 B.t.u. The equivalent evaporation from and at 212 deg. is obtained by multiplying the weight of water evaporated to make up for moisture in the steam by the factor of evaporation, which equals the total heat in the steam minus that of the feed water entering the fuel in entering the boiler, divided by 970.4. In our case it will be 1195 — 133.86 ÷ 970.4 = 1.093, which is the factor of evaporation. The total amount of water evaporated times the factor of evaporation is 29,694 × 1.093 = 32,455 lb. evaporation from and at 212 deg. F. The equivalent evaporation from and at 212 deg. F. per square foot of water-heating surface would be 32,455 ÷ 1500 = 21.6 lb. Of course, the hourly total of this will be one-tenth of the total, as the test is to run ten hours, or 2.16 pounds.

"The next thing we want to do is to find the horsepower developed."

"Yes, that's another thing I never could get straight. How do you do it?"

"It's simple. You know that the standard boiler horsepower is the evaporation of 34.5 lb. of water per hour from and at 212 deg. F. To express the performance of a boiler in the terms of horsepower, we will just divide the total equivalent water evaporated from and at 212 deg. by the duration of the test in hours and the result by 34.5. Looking at our table, the total water evaporated is 3245 lb. per hour and 3245 ÷ 34.5 = 94.057, or 94.1 hp. The rated capacity of the boiler per hour would be the heating surface times the standard for a boiler horsepower divided by 10, or (1500 × 34.5) ÷ 10 = 5175 lb. The rated capacity would be 94.05 ÷ 150 = 62.7 per cent.

"The water fed per pound of coal as fired is 30,300 ÷ 3916 = 7.74 lb. And the water evaporated per pound of dry coal in 29,694 ÷ 3740 = 7.94. The equivalent evaporation per pound of coal as fired is 32,455 ÷ 3916 = 8.29, and the equivalent evaporation per pound of dry coal is 32,455 ÷ 3740 = 8.68 pounds.

"There is one more item we want to figure and that is the efficiency of the boiler. It requires 970.4 B.t.u. to transfer one pound of water at 212 deg. into steam at 212 deg. and the test shows that 7.94 lb. of water was evaporated per pound of dry coal, which required 970.4 × 8.68 (item 33) = 8423 B.t.u.; then, 8423 × 100 ÷ 13,500 = 62.4 per cent.

"This boiler performance would not be anything to brag about, but it probably is as good as a lot of other plants that are being run on the same basis as this one. The best thing you can do is to study this test sheet until you are familiar with it, assuming the necessary data and figure out for yourself the various values. Then get things ready and run the test. I guess this will be enough for this time and so I will start for home and see if the bugs have left anything in my war garden."

PRINCIPAL DATA AND RESULTS OF BOILER TEST

Date, Aug. 4, 1918.

(1)	Number and kind of boiler, one return tubular, hp.	150
(2)	Kind of furnace	hand-fired
(3)	Grate area, sq.ft. (6 x 6 ft.)	36
(4)	Water-heating surface, sq.ft. (10 sq.ft. per boiler horsepower	1500
(5)	Ratio of water-heating surface to grate area (Item 4 ÷ Item 3)	41.7
(6)	Duration of test, hours	10
(7)	Kind and size of coal	bituminous run of mine
	Average Pressure, Temperatures, Etc.	
(8)	Steam pressure, gage, lb.	150
(9)	Temperature of feed water, deg. F.	166
(10)	Temperature of gases leaving boiler, deg. F.	480
(11)	Moisture in steam (assumed), per cent	2
(12)	Percentage of moisture in coal, per cent	4.5
	Total Quantities	
(13)	Total coal burned, lb.	3916
(14)	Total dry coal burned, lb. (Item 13 — Item 13 × Item 12)	3740
(15)	Total dry coal burned per square foot of grate surface, lb. (Item 14 ÷ Item 3)	103.9
(16)	Ash in coal, per cent. (262 lb. ash; 262 ÷ Item 14)	7
(17)	Total water fed to boiler, lb.	30,300
(18)	Total water evaporated corrected for moisture, lb. (Item 17—product of Item 17 + Item 11)	29,694
(19)	Factor of evaporation	1.093
(20)	Total equivalent evaporation from and at 212 deg. (Item 18 × 19)	32,455
	Hourly Quantities and Rates	
(21)	Dry coal consumed per hour, lb. (Item 14 ÷ 10 hours)	374
(22)	Dry coal per sq.ft. of grate surface per hour, lb. (Item 14 ÷ Item 3 ÷ 10)	10.39
(23)	Water evaporated per hour corrected for moisture, lb. (Item 18 ÷ 10 hours)	2969
(24)	Equivalent evaporation per hour from and at 212 deg. F. (Item 18 × Item 23)	3245
(25)	Equivalent evaporation per hour from and at 212 deg. F. per square foot of water heating surface, lb. (Item 24 ÷ Item 4)	2.16
	Capacities	
(26)	Evaporation per hour from and at 212 deg. lb. (same as Item 24)	3245
(27)	Boiler horsepower delivered, hp. (Item 26 ÷ 34.5)	94.05
(28)	Rated capacity per hour from and at 212 deg. F., lb. (Item 4 × 34.5 ÷ 10)	5175
(29)	Rated boiler capacity developed, per cent. (Item 27 ÷ Item 1)	62.7
(30)	Water fed per pound of coal as fired, lb. (Item 17 ÷ Item 13)	7.74
(31)	Water evaporated per pound of dry coal, lb. (Item 18 ÷ Item 14)	7.94
(32)	Equivalent evaporation per pound of coal as fired, lb. (Item 20 ÷ Item 13)	8.29
(33)	Equivalent evaporation per pound of dry coal (Item 20 ÷ Item 14)	8.68
(34)	Calorific value of coal as fired, B.t.u. (assumed)	13,500
(35)	Efficiency of boiler and furnace, per cent. (970.4 × Item 33 × 100 ÷ Item 34)	62.4

Manila ropes and slings last much longer if painted over with beeswax and resin, about equal parts of each—melted together. The rusting of wire cables and ropes is arrested by treating them with a mixture of tallow and oil, seven or eight pounds of melted tallow to a gallon of oil; and when the mixture is cold lime is added until it is thick. It is then applied with a brush.

The Electrical Study Course—Common Faults in Machine Installation

Describing some of the difficulties most frequently encountered in the installation of generators and motors and explaining some of the unexpected consequences that may be produced by apparently insignificant causes.

DIFFICULTIES are frequently encountered in the operation of generators and motors which appear quite baffling when they occur for the first time, and it is the object of the present lesson to deal with some of those which experience has proved to be the most common.

When placing self-excited generators in service, one of the most usual forms of trouble likely to manifest itself is the refusal of the machine to "build up." That is, no appreciable voltage can be obtained from it. If it has been ascertained that the connections have been made properly and that there are no open circuits, the trouble may be due to one of several causes. Perhaps the most common one is that the field winding

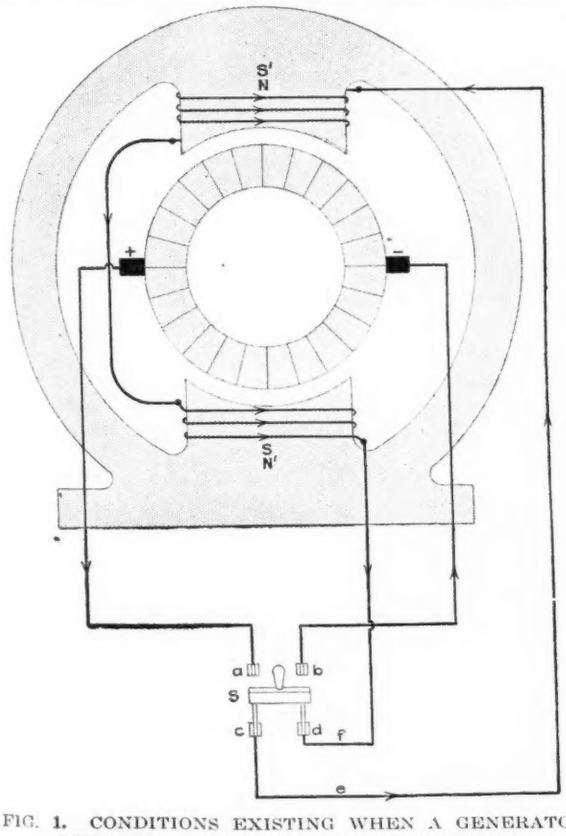


FIG. 1. CONDITIONS EXISTING WHEN A GENERATOR REFUSES TO BUILD UP DUE TO REVERSED FIELD CONNECTIONS

is connected to the armature in such a way that the direction of the voltage generated by cutting the residual field flux tends to send a current through the fields in a direction that would cause them to have polarities opposite to the ones due to the residual flux. This condition is illustrated in Fig. 1, in which *N* and *S* represent the polarities due to the residual field, whereas the polarities developed by current flowing in the coils would be *N'* and *S'*. Suppose the generator to have been started with the field switch *S* open, and that 15 volts was being generated under these conditions due to the conductors cutting the residual flux created by a north pole at *N* and a south pole at *S*.

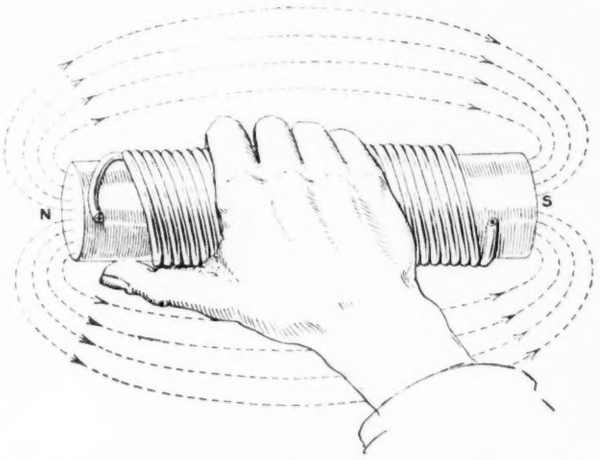


FIG. 2. METHOD OF DETERMINING POLARITY OF AN ELECTRO-MAGNET WHEN DIRECTION OF CURRENT IS KNOWN

If the switch *S* were now to be closed, current would immediately flow through the field windings in the direction of the arrowheads, owing to the 15 volts furnished by the armature, but if we apply the right-hand rule as illustrated in Fig. 2, it becomes evident that polarities *N'* and *S'* would be created directly opposite to *N* and *S*. That is, the magnetization due to the field current would be opposed to the residual flux and would therefore reduce the excitation due to it. Consequently, the machine could never build up because its flux would have to be reduced to zero before it could increase in the direction of the exciting current, and there would then be no generated voltage and consequently no field current. The condition described is usually indicated when a voltmeter connected across terminals *ab* reads a higher voltage with switch *S* open than with it closed. It will be found that some voltage does exist across *ab* even under these circumstances. In order to make the machine build up it would be necessary to connect lead *e* to terminal *d* and lead *f* to terminal *c*, as shown in Fig. 3. The direction of the current through the field windings will then be such as to create *N* and *S* poles corresponding to those due to the residual field; that is, the flux due to the field current will be in the same direction as the residual flux and the machine can accordingly build up.

Another common cause for failure to build up is that too much resistance has been inserted in the field circuit. It would seem that if the field rheostat contained even a considerable amount of resistance the machine would still build up to a fairly high value, but such is not the case. If, for example, the rheostat resistance had the same value as that of the field windings and

were all placed in series with them, the total field circuit resistance, or field resistance as it would be called, would be doubled. If asked what voltage the generator would build up to under these conditions, it might appear that one-half would be the correct answer. A slight amount of consideration, however, will serve to prove the fallacy of such a statement. Suppose the machine to be generating normal voltage on open-circuit and that the field resistance is then suddenly doubled. The field current will immediately decrease one-half, which will cause a great decrease in field flux and hence in generated voltage. As the voltage drops the field current will decrease still more, thereby decreasing the voltage again, which will react on the field current as before, and this process will continue until

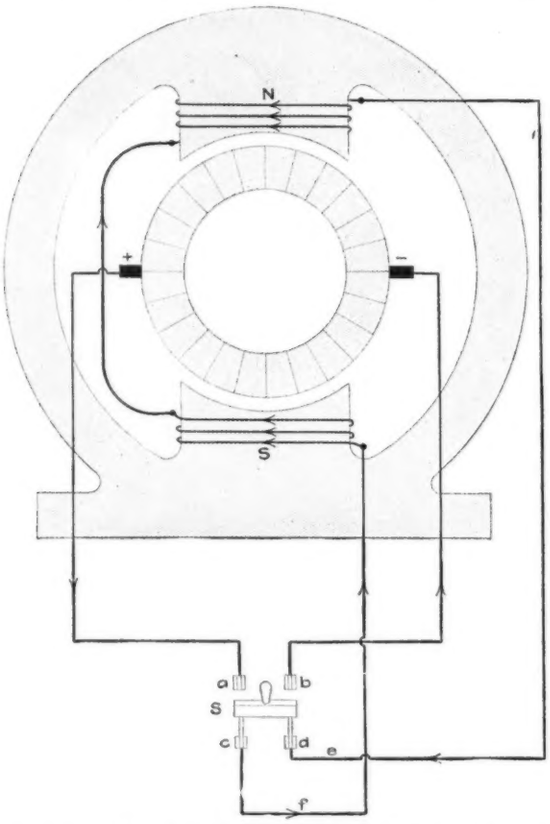


FIG. 3. FIELD CONNECTIONS CHANGED TO MAKE GENERATOR BUILD UP AFTER ITS REFUSAL TO DO SO

the voltage has reached a final value which will of course be very much less than one-half normal. Under such conditions the voltmeter would indicate a very small increase in voltage when the field was connected across the armature—so small in some cases as to be only a fractional increase over that due to the residual flux alone. The remedy is obviously a decrease in field resistance.

A special case of the foregoing trouble is sometimes encountered in the shape of high brush contact resistance. Since the field current has to pass from the armature to the field coils through the brushes, any resistance existing at the brushes is in the field circuit. It is not unusual to find that a generator will refuse to build up owing to this cause, and it is quite baffling to anyone not familiar with it. The machine may have been running normally when shut down and absolutely no changes have been made in field-rheostat adjustment nor in any other way, and yet when started the next time it may refuse absolutely to build up its voltage. In such a case it is well to put extra pressure on a pair of the brushes momentarily, before concluding that any fault has developed in the generator or in its control apparatus and connections. Sufficient contact

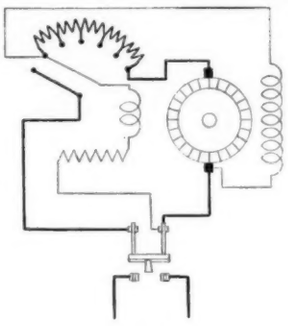


FIG. 4

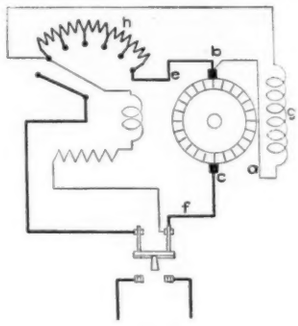


FIG. 5

FIGS. 4 AND 5. CORRECT AND INCORRECT CONNECTIONS OF A SHUNT MOTOR AND ITS STARTING RHEOSTAT

will be obtained to cut down the resistance to a point where the machine can build up.

In testing, a generator may perhaps be run at less than normal speed and in such a case the voltage will be low. In fact, it is possible to have a machine which will completely refuse to build up if run at even such a speed as 50 per cent. of normal. One could readily jump at the conclusion that at half normal speed we should be able to generate half normal voltage, but such is not the case, as can readily be shown. Assume a generator to be running at normal speed and generating normal voltage at no load. If the speed were now reduced to one-half its normal value, the voltage would be reduced a like amount if the field were to remain constant, but the field coils are connected to the generator armature, consequently the current through them will diminish as the voltage decreases, so that when the speed drops to half, the field current will be much less than it was at full speed and the voltage will consequently be very materially below half of normal. As already stated, it may be no greater than the voltage developed at full speed with only

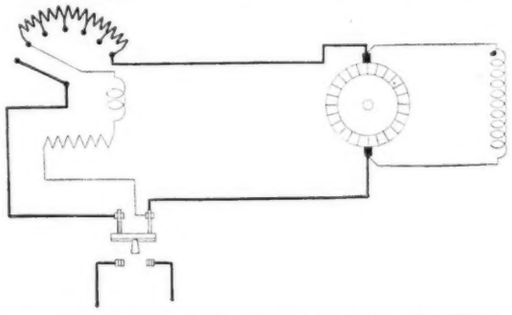


FIG. 6. DIAGRAM SHOWING INCORRECT METHOD OF CONNECTING FIELD COILS OF A SHUNT MOTOR

residual flux present, so that the machine exhibits every symptom of refusal to build up merely on account of its reduced speed.

Occasionally, a generator will refuse to build up for lack of residual magnetism; that is, due to some cause, the residual magnetism present when last operated has disappeared when put into service subsequently. Since

no flux is present no voltage will be generated and the voltmeter will read zero. In such a case the field must be "flashed" by connecting it to some other source of voltage. If no direct-current supply is at hand, storage batteries must be resorted to in order to furnish sufficient field current to allow the machine to excite itself.

Once generators have been put into service and operated satisfactorily, it is not often that they develop troubles, since their connections are permanently made and the correct operating conditions assured. Motors, on the other hand, are more or less frequently changed around, and often old machines which were discarded at some previous time are put in service for some temporary or special service, besides which new motors are to be installed from time to time. The chances of encountering difficulties in the installation and operation of motors are therefore considerably greater than is the case with generators, and it will be worth while giving the subject careful attention.

The most usual trouble experienced in "hooking up" a motor is due to the fact that errors are likely to occur in making the connections to the starting box. In Fig. 4 is shown the correct manner of connecting up a shunt motor, and in Figs. 5 and 6 are illustrated two of the faults most likely to be met with. In Fig. 5 the lead *a* should be connected to brush *c* instead of to brush *b*. The trouble appears quite obvious in the diagram, but in an actual case of connecting up the wires *e* and *f* may be of considerable length and it would require careful tracing out to be sure which one connected to *b* and which to *c*. If the connections were to be made as in Fig. 5, the motor might start satisfactorily at the moment the contact arm was brought to the first position, but it would speed up rapidly, and if an attempt were made to cut out all the starting-box resistance, there would be no field excitation and the motor would "run away." The reason for this is quite simple, as an inspection of the diagram will show. As the connections exist the field *g* is in multiple with the starting resistance *h*. At the instant contact is made with the first button a large current flows through the resistance and the voltage across it will be nearly that of the supply circuit. For example, if the motor armature resistance were 0.2 ohm and that of the starting box 2 ohms, the current at starting on 110 volts would be 50 amperes, and the voltage across the starting-box resistance would be its value in ohms multiplied by the current, or $2 \times 50 = 100$ volts. Since the field is connected in multiple with the starting-box resistance, its voltage will also be 100 volts, which is near its full value and the motor will start at very nearly full field excitation. As it begins to revolve, however, the current will of course decrease and as it does so the drop across the resistance will become less. Assume, for instance, that the current decreases to 5 amperes; the voltage drop across the resistance will then be $2 \times 5 = 10$ volts, which will cause the field current to have $\frac{1}{11}$ of its normal value, thereby compelling the armature to revolve at a tremendously increased speed. If the arm of the starting box were to be moved to the running position, there would be no current through the resistance and consequently no voltage drop across it and hence no current through the field. An attempt to start a motor under the conditions named would result in violent sparking at the brushes and excessive speed, and, if persisted in, would probably operate the fuses or circuit-breakers in the line, although there would always be the possibility that the motor would run away if the protective devices did not function quickly enough.

The typical diagram of connection for shunt motors is often represented as in Fig. 7, which might lead one to believe that it would be correct to connect the field as shown in Fig. 6. This would, however, not be the case, and for the following reason: As just explained, the voltage across the starting resistance is nearly that of the circuit at the instant contact is made, consequently the voltage across the armature would be very low—in the case of the example given it would be 10 volts. When the field is connected as shown, its voltage must be the same as that of the armature; consequently the field current would be very small at the instant of starting. The motor will usually refuse to start under these conditions, with the result that the starting-box resistance will be burned out if the attempt to start be continued.

Compound motors offer precisely the same possibilities for incorrect connections as the shunt type, since they have a shunt-field winding exactly as the shunt motor has. The field excitation will, however, never

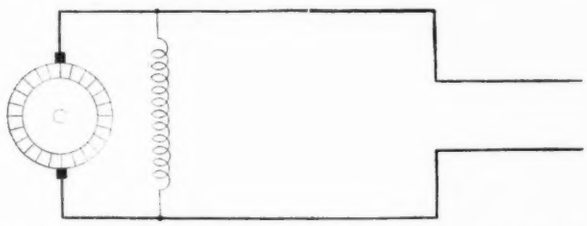


FIG. 7. CONVENTIONAL METHOD OF REPRESENTING CONNECTIONS OF A SHUNT MOTOR ARMATURE AND FIELD

be so small as in the shunt machine under the same circumstances, owing to the flux furnished by the current which flows through the series-field winding. One additional precaution must be observed, and that is to ascertain that the series-field winding is connected for cumulative excitation and not for differential excitation. That is, that the direction of the current through the series field is such as to furnish a flux which is in the same direction as that due to the shunt field, not opposite to it. A convenient test for this is to short-circuit the series field of the motor so that no current flows through it when the machine is run, and observe the direction in which the armature rotates. Then remove the short-circuit from the series field and open the shunt-field circuit, thus converting the motor into a series machine. Now bring the starting-box arm to the first contact button momentarily and note the direction in which the armature begins to rotate. If the rotation is in the same direction as when tried with shunt field, it is an indication that the magnetic flux due to one winding is in the same direction as that due to the other. If the direction of rotation is opposite, it shows that they are opposed and it will be necessary to reverse the connections of either the shunt or the series field, depending upon which direction of rotation is desired.

The connection of series motors is not likely to occa-

sion any difficulties when used on nonreversing service, since the field is directly in series with the armature and there is consequently only one circuit to be considered instead of two in multiple, as in the case of shunt and compound machines. If connected to a controller designed for forward and reverse operations, it will of course be necessary to use ordinary precautions to insure making correct connections, but there are no specific errors to be avoided.

The problem in the last lesson consisted of determining the current required at 230 volts to heat 50 gal. of water from 50 to 170 deg. F. in 6 hours. It was also required to find the resistance of the heater and the resistance of each of the four sections into which it was divided. From the information that it requires 1 B.t.u. (British thermal unit) to raise the temperature of 1 lb. of water 1 deg. F. and the further knowledge that 1 kw.-hr. is equivalent to 3415 B.t.u., it is possible to determine the input for which the heater must be designed. We first find the weight of water to be heated, which is the number of gallons given, namely 50, times the weight of one gallon, approximately 8.4 lb.; that is, $50 \times 8.4 = 420$ lb. Since 1 B.t.u. is required to heat 1 lb. of water 1 deg. F., it would take $420 \times 1 = 420$ B.t.u. to raise the temperature of the water one degree. The temperature of the water is to be increased from 50 to 170 deg. F.; that is, its temperature is to be raised 120 deg. Since it takes 420 B.t.u. to raise the temperature 1 deg., it will require $420 \times 120 = 50{,}400$ B.t.u., to raise it to the desired temperature, which divided by the number of kilowatt-hours per B.t.u. gives $\frac{50{,}400}{3415} = 14.76$ kw.-hr. the amount of energy required. Six hours are allowed in which to heat the water and we divide the kilowatt-hours by the hours to get the kilowatt input, from which $\frac{14.76}{6} = 2.46$ kw., the required input. Multiplying by 1000 we have 2460 watts, which divided by the voltage, 230 volts, will give us $\frac{2460}{230} = 10.7$ amperes. The resistance of the heater would consequently have to be $\frac{230}{10.7} = 21.5$ ohms. If it consists of four sections in multiple, each section would have to have four times the multiple resistance, or $4 \times 21.5 = 86$ ohms.

An electrically operated hoist in a vertical shaft 600 ft. deep is to be capable of raising a load of 3 tons to the surface in 1½ minutes. Neglecting losses, what size motor would have to be used? If its efficiency were 90 per cent. what current would it take at 500 volts? What type of motor would be best suited to the service?

What Six Billions Will Do

TOO many people look upon the vast sums expended in the maintenance of the various branches of war activity as a total loss to the world. They see millions upon millions of dollars invested in powder and shell, in gas and grenade, to be dissipated in smoke clouds, hailstorms of shattered steel and thunderous detonations.

It is true that much treasure has been spent and is irretrievably lost. Modern warfare has no equal in its destruction of life and property. But the establishment of shipbuilding plants, the building of vessels that will eventually form part of the greatest merchant marine in the world, the construction of wharves—these are permanent works of value. Besides, billions have been loaned to our Allies, all of which will be repaid.

The Fourth Liberty Loan will continue these services. But the greater part of the six billions will be directly used to further the prosecution of the war. It will go into guns and ammunition, airplanes and artillery, food and clothing; it will transport fresh millions of fighting men—men of the same courage and initiative as those who took Saint-Mihiel—from America to Europe; it will come to the financial aid of those nations with whom we have made common cause; and it will, through all these channels, produce the concentrated force that will overthrow the Hohenzollern dynasty, already tottering to its downfall.

That will be the splendid sequel to the full subscription of the greatest loan in history. It will carry a victorious American army across the Rhine and through the heart of Germany to Berlin; it will redeem the Lost Provinces and restore Belgium to the remnant of its brave people; and it will reëstablish peace and tranquillity in a turbulent and war-sick world.

But its effects will come home to the individual. Every purchaser of Liberty Bonds in this fourth campaign will be a better citizen and a stronger patriot in the knowledge that he has had a definite and a vital part in the success of American arms and the triumph of American principles.

A Live Wire

EDITORIALS

Engineers for War Service

ENLISTMENT in the army is no longer possible; needed men are now drafted. The great bulk of power-plant engineers are in the second draft; but this does not mean that all those who are drafted will perform the services of power-plant engineers when they get into the army, despite that engineers are needed, and needed badly. Once a man is drafted into the army, has finished his military training and gets abroad as an infantryman, for example, custom quite rigorously forbids his transfer to another army branch where he might perform those services for which industry had fitted him. Perhaps this is as it should be. We will not argue the point here.

There is need of engineers in our armed and in our mercantile service; there is urgent need for many engineers, particularly for refrigerating engineers, in certain branches of the army. Conditions are such that the army cannot take time to "make" all of these engineers; it needs them now, today, not next week or next month. The army wants to know where these men are. True, the questionnaire carries such information, but it seems, for the present at least, that finding them by way of the questionnaire is not done.

An engineer now in the draft may have himself inducted into the service and assigned to power-plant work. He immediately would get the rank of corporal, or sergeant, if qualified, or he might continue as private for awhile, depending upon his qualifications. The chances for a commission later for the bright fellow who thoroughly understands his business is not remote.

Engineers in the draft who are engaged in industries nonessential and have no serious burdens in the way of dependents, could put the next few weeks to good use by making themselves and their experience known to the war office. We have no official advice asking us to do so, but we would direct such men to place themselves on record with the Construction Division, Maintenance and Repair Branch, Room H-115, Seventh and B Streets, N. W., Washington, D. C. This applies especially to men who can successfully handle refrigerating and heating plants. The pay will be according to the rank given; that is, private, corporal or sergeant or according to commissioned rank if commissioned.

The Gasoline Shortage

MANY have doubtless wondered if the recent request of Fuel Administrator Garfield, to the effect that gasoline users refrain from using that fuel on Sundays was really necessary. No one outside of the Administration office appeared to know very much about the situation, and even the refiners themselves seemed to be in the dark as to just what the conditions really were as regards the gasoline shortage.

According to data just supplied by Dr. Garfield, brought out by the recent resolution by Senator Lodge, there is a serious gasoline shortage, both for home consumption and for shipment abroad. The figures compiled by the Oil Division of the Bureau of Statistics show that there is a reserve supply for only about thirty days.

It was because the daily stock of gasoline was constantly diminishing, owing to the heavy war demands, of more than four million barrels since April, and with a similar ratio would indicate a deficit in production, amounting annually to approximately two million barrels, that the request was made.

According to Dr. Garfield, in order to make up the shortage in production it was necessary to take from the California yield, which has fallen off in the same proportion as that in the East. The problem of a low stock of gasoline throughout the country affects the entire gasoline situation, of course. According to figures given, there would be at the rate of past consumption a deficit for the year of about one million barrels, and this may be greatly increased by additional war demands.

Thus it will be seen that observance of the request for the gasless Sundays is really necessary if a sufficient surplus is to be maintained for war purposes.

How About the Heating System?

UNLESS one's plant is located south, the heating season is now well under way. Presumably every engineer has made good use of the summer months to put the heating plant in the pink of condition, especially after the trying times during the unprecedented cold of last winter.

By this time men responsible for the heating of buildings should have provided to let no exhaust steam or hot drains go to waste so long as these may be made to furnish heat and thus save fuel. There are plants where it is or has been no uncommon practice to have exhaust steam blowing through the back-pressure valve to the atmosphere while live steam is turned into the heating system. There is no excuse for this bad engineering. Now it is worse than ever—it is unpatriotic. Unless such practices are stopped, engineers need have no hope of making up the shortage of fifty million tons of coal which must be made up if our war and industrial programs are not to suffer.

Successful and economical heating is surely as much a matter of distribution of the steam or water or air as it is one of boiler, radiators and pumps. Some day some bright fellow will put as much thought into distribution in heating buildings as the electrical men have put into the illumination of them. The coal pile will be the better for it to an immeasurably greater extent than it owes to correct illumination. And this question of proper distribution applies as well to the supply mains as to the radiators in particular rooms. Many a coal pile may

be conserved if instead of driving live steam, during extra-cold periods, to great distances from the boilers by way of the main heating supply pipes, a small connection is taken off an adjacent line at the nearest possible point of use of the steam or local heating demand.

We do not believe that this is a time to waste fuel in air purification unless such purification is necessary to the health and productivity of employees. Proper ventilation is essential; let us have it at the lowest cost in coal. An engineer is justified in protesting against the fresh-air enthusiast's persistence in keeping all windows open in utter disregard of whether ventilation is or is not adequate with window adjustment that insures minimum use of coal.

By this time all vacuum lines from radiators should be known to be tight and free of obstructions, every stuffing-box should be filled with packing and free from leaks in or out, thermostats should be clean, have new filtering material in them, and their diaphragms, as well as the diaphragms of the valves they operate, should be free from leaks and sure to run through the winter. The pencils or seats in vent valves should have been initially adjusted so that serious losses of heat do not occur because of short-circuiting through these valves. A large heating system requires considerable attention. Men are becoming scarcer—not more plentiful; the same may be said of coal.

For these reasons the heating system should now be ready—in the best possible state of preparedness for the long season's load. Is yours?

Literature for American Marine Engineers

THE United States is soon to become a maritime nation rivaling the position in this field that it held so many years ago. We have more shipways in our shipyards than the rest of the world combined. Chairman Hurley of the Shipping Board announces that the program calls for twenty-five million tons of ships. We do not know just how many million dollars have already been invested in shipbuilding facilities; but there are hundreds. This investment is going to be made to pay returns other than those the immediate realization of which means the winning of the war. The submarine, from the German, as well as the American viewpoint, is a joke. It cannot sink any more of these ships than the lad next door will steal footballs from your youngster. A good share of the ships now building will be afloat and serviceable after the war.

Without wasting breath in peace talk or in league-of-nations proposals, although the latter are fruitful of good, it is certain that we will require a large navy for a large merchant marine.

Ships need engineers. These cannot be made in a a day nor can the material from which to make them be rightly selected in haste. The faster the attempt to produce them the better organized must be the facilities.

One of the most valuable requisites is suitable marine-engineering literature. Many excellent books are published in this country, among which there comes to mind the widely used Durand's "Practical Marine Engineering." But there is a kind of book needed which we do not possess, at least we do not know it if it is available. We have in mind a book like Sothern's " 'Verbal' Notes and Sketches—A Manual of Marine Engineering Practice," but related particularly to American practice. This book is used by Sothern in his school for marine engineers at Glasgow. An American duplicate would have a good future and would be appreciated by the thousands of young men preparing for engine-room service at sea.

Conserve the Paper Supply

EVERY pound of paper requires from one to three pounds of fuel in its manufacture; it utilizes chemicals that are needed in war work; it ties up labor and capital that are urgently required in other industries; and it forms a large percentage of our freight traffic. Therefore, by avoiding, wherever possible, the use of wrapping paper, paper bags, envelopes, letter sheets and the thousand other forms of paper, we are releasing for war work such essentials as coal, sulphur, chlorine, caustic soda and labor, and reducing the burden on our already overloaded transportation systems.

On the other hand, paper that has already performed useful service should not be destroyed. It should be saved and turned over to one of the collecting agencies such as the Salvation Army, school children, or junkmen, so that it may eventually be worked over into lower grades of paper, pasteboard, and the like. We have been wasting paper, just as we have been wasting a lot of other things, and we must learn to save. We cannot continue our old spendthrift ways and at the same time win the war quickly. With such a situation confronting us, there is no doubt as to which course we must choose.

Are the Coal-Port Facilities Ready?

GREATER New York and much of lower New England get practically all their anthracite and some bituminous coal through the fourteen coal piers on the New Jersey and New York water fronts. Last winter some of the largest of these piers were in a shamefully inefficient, woefully underloaded condition during the pathetic fuelless days. A spring and summer have passed. Have these piers been put in condition to handle with dispatch all the coal that can reach them? Will they quickly release or long delay the sorely needed coal cars? Will all available barges be loaded with available coal to avoid delay in transit, or will red tape congest the piers, the railroads and inflict needless suffering? New York is not provided to store its coal; it must get it in streams, supply following demand. Everything should now be in readiness to make it do so.

How Have You Saved Coal?

A SPECIAL pressure has been put upon the power-plant engineer to save coal. How have you responded to this urgency and with what success?

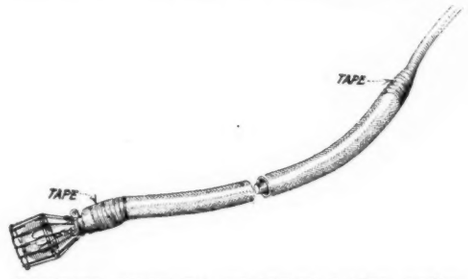
You can render a special service to *Power*, to your fellow engineers, to the Fuel Administration and to the country by telling how you have been successful in improving the efficiency of your plant and what you did to get this result. Our correspondence columns are open for communications upon the subject and we pay for accepted contributions.

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellows how you have saved coal. Power will pay for good articles and letters that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

Safety Suggestion for the Boiler Washer

The illustration shows a length of small-sized hose slipped over the cord of an extension light to be used inside of a boiler, while cleaning. A weatherproof socket should be used and the hose taped to it so that



RUBBER HOSE TO PROTECT LAMP CORD

no moisture can enter, and at the other end the hose should be well taped to the cord in the same way and for the same reason. This extra covering protects the insulation from damage and the user from danger of a shock.

E. G. CHERRY.

Albany, Ala.

Restoring a Broken Motor Field Connection

A three-horsepower shunt-wound motor had a field rheostat temporarily connected with it for the purpose of adjusting the speed. While standing unused a wire

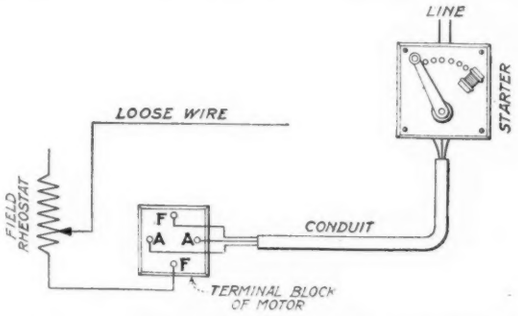


FIG. 1. CONNECTIONS OF MOTOR AS FOUND

had become disconnected from the terminal block of the motor and the writer was asked to replace it.

Fig. 1 shows the way the wiring was found. It was easy to see that the loose wire belonged on one of the armature terminals, but which one? In an effort to find out it was connected to one of the armature terminals and the motor started carefully without load. It started in the right direction, but was seen to be racing before the starter handle was in the running position. The field resistance was all out, so it was evident that an incorrect connection must have caused this behavior. When the wire was put on the other armature terminal, the motor operated properly.

Fig. 2 makes clear the reason for the racing. With the starter handle on the first point the motor had a fairly strong field with the incorrect connection, because it had impressed on it the voltage across the starting resistance, which is a large proportion of the

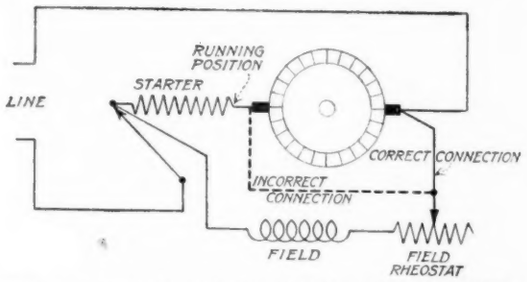


FIG. 2. CONNECTIONS OF MOTOR AS RESTORED

line voltage at the instant of starting, but as the motor starts and thereby reduces the current, the voltage across the field winding is greatly reduced until at the running position of the starter it is zero. Since the speed of a motor increases when the field current is decreased, the motor raced, which fact was detected by the sound. Serious damage might have resulted if the starter resistance had all been cut out.

It will be noticed that with the correct connection the starting resistance is in the field circuit during normal operation, but this does not matter because the value of the starting resistance is only a small percentage of the value of the field resistance.

New York City. S. H. ANDERSON.

Keeping Check Valves from Hammering

The reply to S. A. B. on the "Inquiries of General Interest" page in the issue of Aug. 27 tells how to prevent water-hammer in boiler-feed lines, but there is another annoying condition that is closely akin, namely the hammering of the check valves, which can be corrected as follows:

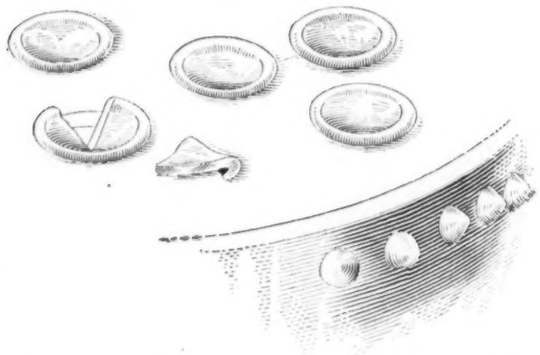
Cut a piece of coil spring the right length to go in between the cap and the swing check to prevent the valve opening wider than necessary. The spring should

exert the least force that will stop the hammering because it is a resistance against the flow of the water. The same is true, of course, with regard to the springs on pump valves.

Anderson, Ind. J. O. BENEFIEL.

An Unusual Boiler-Repair Job

One flue in the boiler of a small steam hoisting engine, used in building a rock dam for a reservoir situated in the Sierra Nevada Mountains in California at an elevation of about 8000 ft. and 50 miles from the nearest machine shop, was injured in shipping.



SMALL RECTANGULAR PIECE BROKEN FROM TUBE END

Some heavy castings came in contact with it and a small triangular piece was broken completely out of the upper end of the tube, as shown in the illustration. This piece was about ¾ in. long on the beaded side and ⅝ in. on the other two sides so that the break extended at least ⅛ in. inside of the boiler head.

As the engine was needed at once, I did not have time to send for a new tube and my first thought was to cap it up with two washers and a long bolt or rod through the tube in the usual manner, but judging from the size of the boiler I would need all the heating surface available. I therefore decided to try replacing the broken-out piece. Its edges were very rough and ragged and putting it in place carefully, I forged a tapered plug, or drift pin, so that the small end would just enter the tube. This drift pin was then heated to almost a welding heat and quickly driven into the tube with a heavy hammer, swaging the broken piece into place, the ragged edges helping to hold it in place. After the plug had cooled, it was removed and the boiler fired up. The tube leaked a little for a few days, but soon took up and no further trouble was experienced with it, although the boiler was steamed "hard" for sixty days until the job was finished.

As we used wood for fuel, we needed this tube badly enough to pay for taking the chance in making repairs in this manner. The tube was old and crystallized—a new one would not have broken, it would have bent.

Livermore, Calif. M. L. LOWREY.

Spontaneous Combustion of Pulverized Fuel

In your report of the Smoke Prevention Association Convention at Newark, N. J., page 398 of the Sept. 10 issue, the statement is made in reporting my remarks that one difficulty manifest in the use of pulverized fuel is that it cannot be stored for lengthy periods without danger of spontaneous combustion.

Although it is probably true that there is slight danger when storing coal that contains moisture for lengthy periods, with the present equipment for handling pulverized coal and with the present design of our "Lopulco" installation, there is very little danger in this regard. There were probably fires from spontaneous combustion in the earlier days when burning pulverized fuel, but now that the characteristics are thoroughly understood, this difficulty has been overcome.

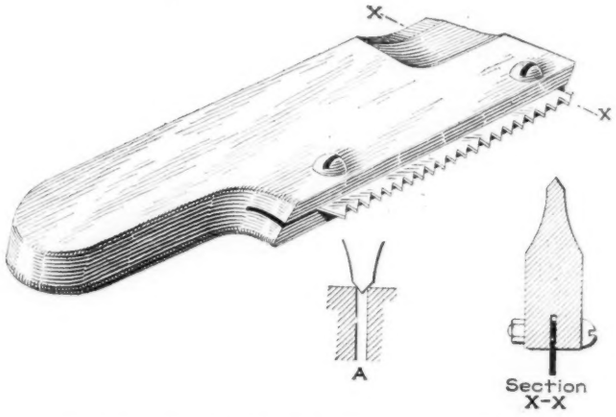
There are other disadvantages in connection with the storing of pulverized coal for any length of time that are more important than the one mentioned in the foregoing. For instance, pulverized coal when stored in bulk for a longer period than 24 hours, begins to pack and bake. With our system, the storage capacity at the several units is so arranged so that there will be no lengthy periods for storage.

H. D. SAVAGE, Vice President,
Locomotive Pulverized Fuel Co.

New York City.

Tool for Undercutting Mica*

For undercutting the mica in commutators I use a tool made as illustrated, and find it entirely satisfactory. The slot in the holder is made as deep or deeper than the width of the hacksaw blade, with small bolts to clamp the blades at each end. Any depth cut desired can be made by adjusting the blade in the holder, but there seldom is occasion to move the blade. The handle part is cut away just enough to allow the fingers to pass over the commutator without rubbing. In undercutting commutators care must be taken that no rough edges are left after the mica is cut, but it is sometimes hard to avoid this, especially if it is an old commutator. These rough corners can be smoothed, after the mica has been undercut, with a V-shaped tool made of hardwood or vulcanized fiber, run between the segments as shown at *A*, and it does not spoil the bar. I use the front corner of the undercutter, which is made of fiber, to smooth these raw edges.



SHORT SAW BLADE CLAMPED IN VULCANIZED FIBER HOLDER

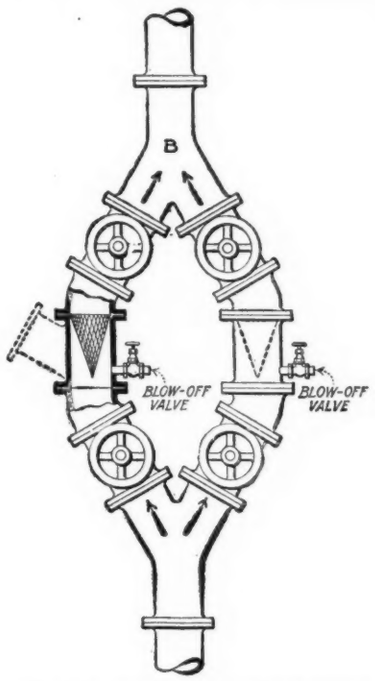
WILLIAM H. WATSON.

Norristown, Penn.

*See also "Power," p. 174, July 30, 1918.

Twin Strainers for Suction Pipe

The illustration shows how easy it is to connect up a pair of strainer chambers in a pipe line when all the fittings are "standard" or those of the same kind are of the same dimensions. For convenience in clean-



DUPLEX STRAINER CONNECTION

ing, a Y (or T) fitting, shown dotted, may be used to contain the strainer which is made cone-shaped as shown, with the small end toward or against the flow.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

Clinkering: Its Cause and Prevention

The article by Mr. Saller in the issue of Sept. 3, page 335, on clinkering gives some good advice as to the beneficial effect of thin fires and light charges, but it seems to me he is somewhat sweeping in his statement to the effect that it should be possible to fire any coal so that the clinkering temperature will not be reached.

I have used some coals, especially some of the kinds mined west of the Mississippi River, that I could not fire thin enough to prevent clinkering and at the same time "keep 'er hot." Mr. Saller's advice in regard to slack is good. It should be fired lightly and the fire kept thin, but I must admit again that there are some kinds of slack that I have never been able to fire without breaking up the crust occasionally by hitting on top with a rake in such a manner that the ashes will not be put on top of the fire.

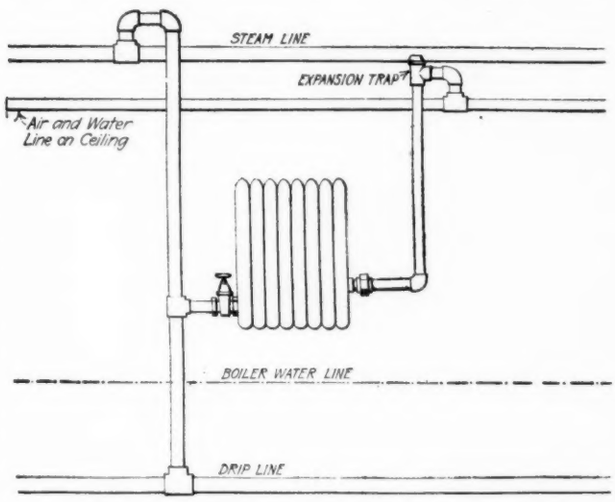
In these days slack is about all that a lot of us can get, and it is up to us to make the best use possible of it, and a little experimenting sometimes shows things that are worth while. For instance, there are two kinds of slack coal quite generally used in this region. One is from southeastern Kansas and is of the caking variety, forming a very hard crust; the other is from the Rocky Mountain region and is noncaking, making a fire that is hard to keep on the grates. The slightest touch sends showers of sparks through the grates, causing considerable loss, but a mixture of equal parts of these two kinds makes as good a fire as one could wish. The opposite characteristics of the two coals counteract each other, giving the fire body enough to stay on the grates and at the same time doing away with the hard crust that is characteristic of the Kansas coal. My experience is that the mixture is more economical and efficient than either one of these coals separately, and I suggest that engineers in the district where these two coals are obtainable try mixing them and note the results. WILLIAM M. ALEXANDER.

Exeter, Neb.

Radiator Connections

In the issue of Aug. 6, page 208, Mr. Enggren, in reply to a letter by Mr. Ellison on page 812 in the issue of June 4, shows a radiator connection, but it will not work satisfactorily on low pressure and under certain conditions which I desire to point out lest some brother come to grief.

The expansion trap, or thermostatic air valve, is located at the radiator, which is wrong where a radiator is placed below the air-line return piping. Whenever the air-line mains are run on the ceiling or above the radiation which they serve, the air valve, or thermostatic expansion trap, that regulates the discharge of air from the radiator must be above the main air line so that condensation will not collect above the air valve, requiring considerable pressure to drive it up the pipe into the main air line. Moreover, the piping leading to the air valve from the radiator should be larger than the usual $\frac{1}{8}$-in. tapping provided in the radiator for this purpose. The radiator should be tapped out



EXPANSION TRAP LOCATED ABOVE AIR LINE

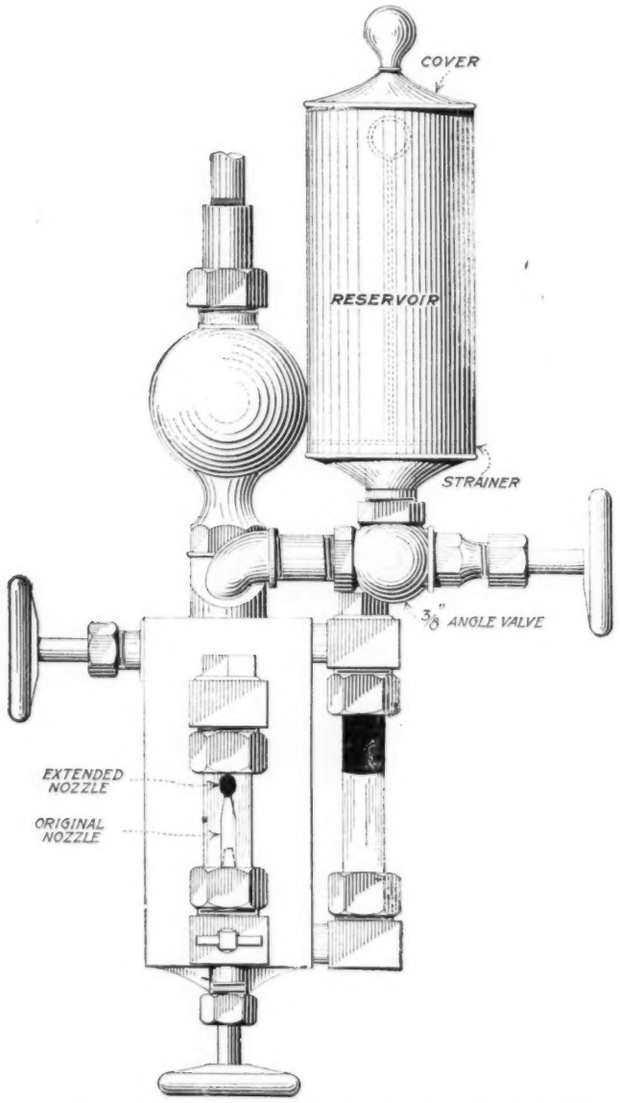
to at least $\frac{3}{4}$ in. and pipe of that size used to prevent the pipe filling with alternate plugs of air and water that will not pass each other in $\frac{1}{8}$-in. pipe.

The illustration shows the location for the air valve as described in the foregoing. No trouble will be experienced with such a connection I am sure, for I have been "through the mill" on the same proposition and found that this arrangement will work under all conditions of service.

Brooklyn, N. Y. W. T. MEINZER.

Handy Lubricator Kinks

The illustration shows two lubricator "kinks"—one an extension on the feed nozzle to prevent the oil from adhering to the sight-feed glass, and the other a "filler" by which the lubricator may be filled quickly without waste of oil by overflowing. In using the filler, the reservoir being full, the feed and water valves are shut and the drain valve is opened, then the ⅜-in. angle valve under the reservoir is opened. As the water drains out of the lubricator, it is replaced by oil from



TWO SPECIAL ATTACHMENTS FOR A LUBRICATOR

the reservoir. As soon as oil shows at the drain valve, it is closed, then the angle valve also and the lubricator is started in the usual manner. The reservoir is then refilled ready for another filling operation.

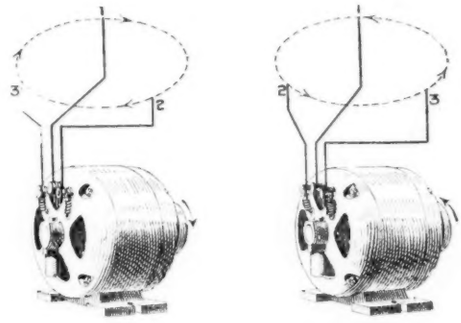
Hayden, Ariz. S. B. RICHEY.

Reversing an Induction Motor

I was much pleased with A. M. Dudley's splendid article on page 271 in the issue of Aug. 20, taking up the reconnection of induction motors. His two concluding paragraphs explain in a splendid manner how the interchanging of any two leads on a three-phase induction motor will reverse the direction of rotation. Some ten years ago I learned this rule in the following form:

Just hook up the leads in any old way
You can't go wrong whatever you do;
If she turns the wrong way you make her reverse
By just interchanging any old two.

The simplest proof of the truth of this rule is one I discovered myself when, as a young fellow, fighting



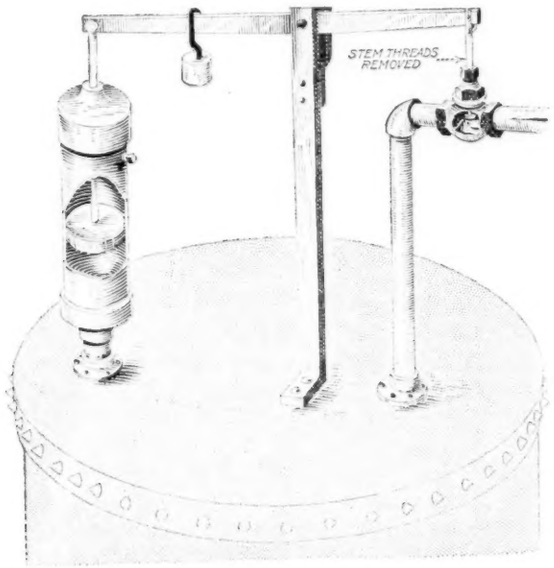
CHANGING ANY TWO LEADS REVERSES MOTOR

out the why of it on a diagram. Juggle the figures 1, 2 and 3 any way possible and they will always be in order around the circle either forward or backward.

Vancouver, B. C., Canada. R. MANLY ORR.

Tank-Pressure Regulator

The illustration shows a pressure-regulating rig attached to a tank in which it was desirable to maintain a presure of about 20 lb. when supplied by a main carrying 80 lb. or more. The illustration makes the construction and operation so obvious that no explana-



PRESSURE REGULATOR ATTACHED TO TANK

tion seems necessary. The pressure within the tank can be varied by the weight on the arm.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

Back our fighting men to the limit. Buy Liberty Bonds.

INQUIRIES OF GENERAL INTEREST

More Rapid Corrosion of Spare Boiler—In one of a battery of boilers used only occasionally, corrosion appears to take place much more rapidly than in the boilers that are in constant use. What is the explanation? L. M. C.

There may be a difference in the material of the boilers, though the less rapid rate of corrosion is probably due to the fact that the oxygen liberated from the water is less active at high temperatures and more rapidly attacks the material of the boiler that is fired only a portion of the time.

Advantages of Brick Lining for Steel Stack—What is the advantage of lining a steel stack with brickwork? C. L.

A brick lining protects the stack from the deteriorating effect of the hot gases and, in addition to preventing corrosion, acts as a heat insulator. Large quantities of heat are lost by an unlined steel stack, and as the buoyancy of chimney gases is mainly due to the difference between their temperature and that of the external air, a stack lining is of considerable importance for obtaining good draft, especially when the waste gases dealt with are at low temperatures.

Total-Horsepower-Hours for Month—During a month the power of a plant was developed by three engines. One of the engines ran 304 hours with an average load of 215 hp., another ran 240 hours with an average load of 320 hp., and a third ran 185 hours with an average load of 280 hp. What was the total output of the plant in horsepower-hours? M. R. W.

The total output for the month would be the sum of the hp.-hr. outputs of each engine, namely,

$$(215\ hp. \times 304\ hr.) + (320\ hp. \times 240\ hr.) + (280\ hp. \times 185\ hr.) = 193{,}960\ hp.\text{-}hr.$$

Computing Speeds Obtained with Train of Gears—What is the rule for determining the speed of the driving and of the driven shaft when two shafts are connected by a train of gears? J. McM.

The r.p.m. of the driving shaft is equal to the product of the numbers of teeth of all the followers, multiplied by the r.p.m. of the driven shaft and divided by the product of the numbers of teeth of all the drivers.

The r.p.m. of the driven shaft is equal to the product of the numbers of teeth of all the drivers multiplied by the r.p.m. of the driving shaft and divided by the product of numbers of teeth of all the followers.

Use of Bent Rocker on Single-Valve Engine—Why is a bent rocker used on the valve motion of some single-valve automatic engines? J. S. B.

On account of the irregularity introduced by the connecting-rod, or, as commonly designated, the "angularity of the connecting-rod," the valve may have equal laps and equal port openings, but the piston positions at cutoff will be unequal and equalization of the cutoff can be made only at the expense of the lead. By the use of a bent rocker an irregularity may be introduced into the valve motion which may be made to equalize the cutoff without interfering with the equality of the lead.

Setting Link-Motion Valve Gear—What is the method of setting a valve with link-motion valve gear? C. R.

If it is assumed that the valve and valve gear are designed for equal leads, place the link at midgear and with the engine on a dead-center, set both eccentrics as near as may be with the proper angular advance. Then place the link at full gear forward and if the valve does not give the proper lead, change the length of the forward eccentric rod to overcome half of the error, or obtain the same result by adjusting the length of the valve rod, and shift the forward eccentric to obtain the proper lead. Then place the link at full gear backward and set the valve again for the proper lead, changing the length of the backward eccentric rod and the angular advance of the corresponding eccentric, as may be necessary for correcting one-half of error by each adjustment. Again place the link at full gear forward and see if the setting has been disturbed by changing of the backing eccentric and eccentric rod. If it has, the valve must be reset, by the same method, first in full gear forward and then in full gear backward until equal leads are obtained. Usually a single repetition of adjustments in forward and backward gear will be found sufficient. If the link motion is designed for unequal leads, as commonly the case with marine engines, then the adjustments must be made with reference to obtaining the proper leads with the engine on first one dead-center and then on the other for both full gear forward and full gear backward.

Placing Engine on Dead-Center—How can an engine be accurately set on a dead-center? W. E. S.

Turn the wheel so the engine is a little off the center to be determined and make a mark on the crosshead opposite to a mark made on one of the guides. Next set a pair of dividers or trammels with one point resting on the bedplate of the engine, its foundation or some convenient stationary object near the flywheel, and with the other end mark a point on the corner of the rim of the flywheel. The engine should then be moved over or beyond the dead-center until the marks made on the crosshead and on the guide come together again. Then with the same opening of the dividers or trammels, and with one end resting on the same stationary point as before, put another mark on the corner of the flywheel rim. If the engine is then turned backward so that the end of the dividers that was used to mark the flywheel is at a point halfway between the two marks, the crank will be on the dead-center required.

Steam Service Reduced to Equivalent Boiler Horsepower—For heating the drying room of a tenant, steam at 120 lb. gage is supplied through a reducing valve at the reduced pressure of 20 lb. gage, and the condensate, amounting to 1020 lb. of water per hour, is returned to the boiler room at an average temperature of 165 deg. F. What number of boiler horsepower should be charged for the service? W. P.

Each pound of dry saturated steam presented to the reducing valve at the pressure of 120 lb. gage, or 135 lb. absolute, contains 1191.6 B.t.u. above 32 deg. F. Conversion of the pressure from 120 to 20 lb. gage, from passing the steam through the pressure-reducing valve, results in a superheated condition for the reduced pressure, but the total heat content of a given weight of steam remains unchanged. Hence if the condensate is returned to the boiler room at a temperature of 165 deg. F., or 165 — 32 = 133 deg. above 32 deg. F., each pound of condensate so returned represents a delivery of 1191.6 — 133 = 1058.6 B.t.u., and 1020 lb. would represent a delivery of 1058.6 × 1020 = 1,079,772 B.t.u. per hour.

A boiler horsepower is equivalent to the evaporation of 34.5 lb. of water per hour, from and at 212 deg. F., and as the latent heat of evaporation at 212 deg. F. is 970.4 B.t.u., a boiler horsepower is equivalent to 34.5 × 970.4 = 33,478.8 B.t.u. per hour, and service of steam under the conditions stated would be chargeable as 1,079,772 ÷ 33,478.8 = 32.2 boiler horsepower.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Are There Advantages in Welding Boiler Plate?*

By HOWARD L. BOYD
Mechanical Engineer, Industrial Accident Commission

The author points out the dangers of using metal for welding boiler plate which is of a chemical composition different from that of the metal in the plates.

THERE is a wide divergence of opinion regarding the advisability of oxyacetylene welding on boiler plate where there is considerable pressure to be used. In some countries the process has been brought to a high degree of perfection owing to the insistent demand for quick repairs, cheap repairs, and with the added ability arising out of long experience in acetylene welding.

The chemistry of oxyacetylene is well known, but not until recent years has the application been so wide that boilermakers and users felt justified in introducing the oxyacetylene torch in patching boilers. Considerable experience is required by the operator in the handling of the torch to prevent burning of the metal.

There have been numerous attempts made at producing a joint between two pieces of steel, using a third piece as the welding medium. And inasmuch as a small divergence in the chemical composition, or even in the mechanical structure of the third element, has much to do with the cohesive power of the weld, it is obvious that the difficulty is great in producing a weld that will show anywhere near the tensile strength of the original plate.

What may be said regarding welding is true of a riveted seam up to certain limits. It has been proved in tests on boiler plate that the average oxyacetylene weld has an efficiency in the neighborhood of 70 per cent., although tests have been made in which the efficiency has run much higher. This would be a fair comparison with a lap-double seam of the ordinary 44,000-lb. shear of rivets, using a tensile strength of 55,000 lb. for plate.

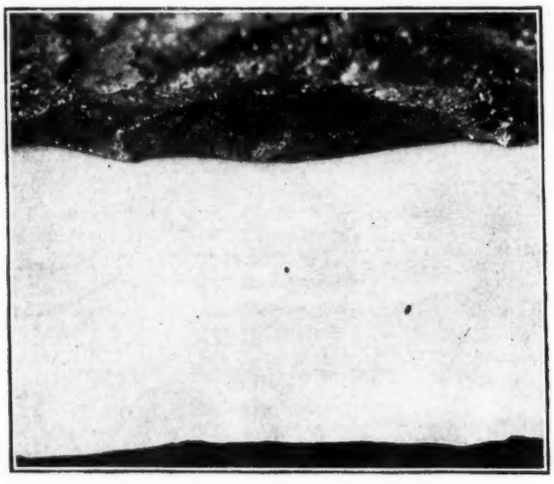


FIG. 1. MAGNIFIED CROSS-SECTION THROUGH WELD IN PLATE NO. 2

Following is a table of tests made of three pieces taken from new boiler plate.

Plate No.	Quality	Content, Per Cent., Copper	Variation Thickness, In.	Tensile Strength, Lb.	Breaking Strength, Lb.	Thickness of Plate, In.
1	O. H. flange.....	0.03	0.02	60,000	99,270	½
2	O. H. flange.....	0.03	0.012	60,000	77,320	½
3	O. H. flange.....	0.03	0.024	60,000	68,820	½

Fracture of plate: (1) Small, well-defined crystals, close-grained; (2) coarse grained, spongy, well knit; (3) coarse, fibrous, loose and open.

*From the "California Safety News" of the Industrial Accident Commission of California.

Plate No. 1 was ½-in. thick by 3 in. wide by 15 in. long. The characteristic constituents were modified to some extent by 0.03 per cent. copper. The bar was cut from a boiler plate, openhearth flange, 60,000 lb. tensile strength, placed in a planer and planed down to size. The variations in thickness were 0.02 in. The plate was placed in an Olsen testing machine of 200,000-lb. capacity. The strain broke the plate at 99,270 pounds.

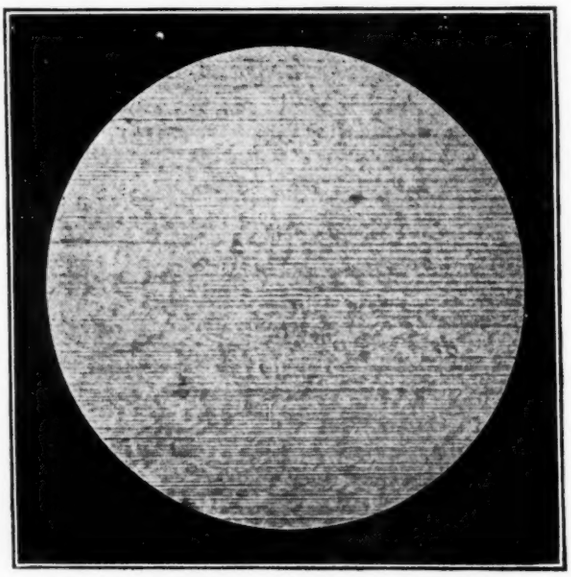


FIG. 2. MAGNIFICATION OF WELD IN FIG. 1

Plate No. 2 was cut from the same sheet, ½ in. thick, 3 in. wide, 15 in. long and varying 0.012 in thickness, openhearth flange steel, 60,000 lb. tensile strength, welded, then placed in the machine, breaking the weld at 77,320 lb., which shows the efficiency of the welded joint was in the neighborhood of 77 per cent. The fractures of the original plate showed irregular, homogeneous crystallization, small and definite; and in the case of the welded joint, in which were used the shavings from the same plate, the crystals at point of fracture through the weld were somewhat larger and more irregular than found in the original plate.

For the third plate test conditions were identical with the two preceding, except for the use of ordinary bessemer-steel welding rods. This weld showed the least strength, although apparently as much pains were taken to make the weld as nearly identical in point of method and size as in case of the first test.

This concludes to a certainty that the welding steel should be as nearly as possible the same composition as the plates on which it is to be used. In many instances the operators have used foreign compositions, and built up a weld which was supposedly strong, but, owing to the advent of high or low carbon, or even of a small portion of manganese, and possibly modified by a copper content, the weld was not such that it would properly knit with the adjoining plate. In fact, there have been instances in which ordinary wrought-iron was melted down in welding a steel plate. It goes without saying that such a procedure is decidedly unwise and is not to be considered when a job of welding is at hand.

Cases have been noticed in which spring steel has been used on ordinary flange-steel boiler plate, thinking that perhaps the steel having higher tensile strength would make a better joint than the homogeneous steel could possibly make.

It is not to be considered as a theory that a high-carbon steel in connection with a low-carbon plate is going to perform the same mechanical joining that a high-carbon steel

in a high-carbon plate would make, and unless there is some effort put forth to get steel of nearly the same chemical constituents, we cannot hope to produce as good welded joints as otherwise.

In the tests cited no effort was made toward finding the

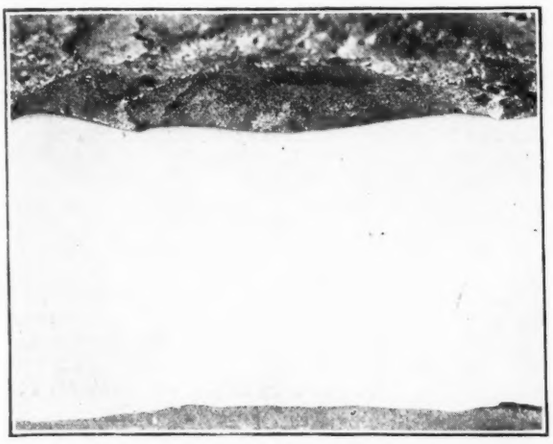


FIG. 3. OTHER HALF OF FIG. 1, HIGHLY POLISHED

percentage of elongation or the subsequent reduction in area. It was for the sole purpose of determining at what point the original plate would break as compared with the breaking point of the welded joints.

Fig. 1 shows a photo enlargement of a cross-section through the weld of plate No. 2 of the table for the purpose of determining what the structure might be when the edges of the weld were polished. There are no visible sutures.

Fig. 2 is the magnification to 40 diameters of a section through the weld shown in Fig. 1. It is almost impossible to get the striations positively eradicated. It does lead to the conclusion, however, that the weld is so nearly homo-

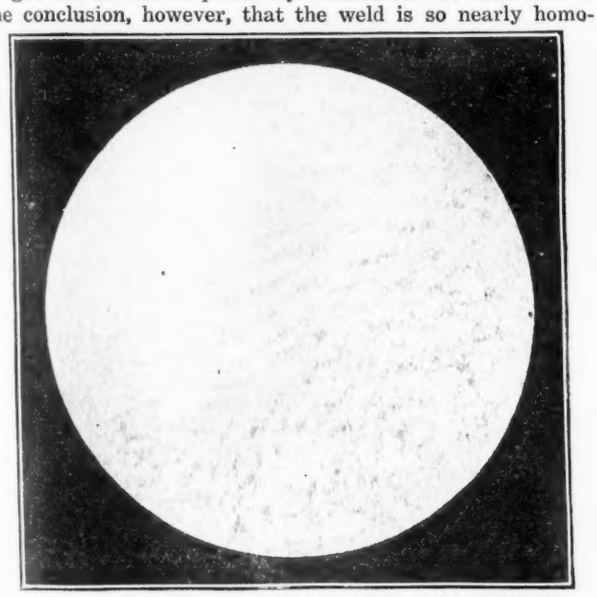


FIG. 4. CRYSTALLIZATION OF FIG. 1, MAGNIFIED 40 DIAMETERS

geneous with the plate that it cannot be seen under a magnification of 40 diameters. The weld was made and the plate was sawed into halves, the edges buffed and polished and the results obtained as noted.

In Fig. 3 is seen the other half of the same piece of plate, highly ground, buffed and polished and then etched with nitric acid. The V-weld cannot be seen with an enlargement, as noted, of 40 diameters.

Fig. 4 shows the crystallization of Fig. 1, magnified 40 diameters, through a suitable place where the weld is supposed to have knitted with the original plate. The crystallization is almost perfect.

Fig. 5 is a reproduction of Fig. 3, magnified 80 diameters, and gives a clear idea of how the metal flows in a V-weld. There is absolutely no burning, no slag present, no oxide scales, no blowholes—in fact, no imperfections.

Fig. 6 is an enlargement of the ground edge through the weld. In the upper center of the picture will be seen the irregularities produced by the molten metal. It was not the intention to build up the weld beyond the thickness of the original plate, but simply to make a clean, clear bridge between the edges.

When considered from the viewpoint of efficiency, as ordinarily recommended on a riveted joint, if the weld is made with metal of the same constituency as the sheets to be welded, and secondly, if time is used to facilitate the gradual heating of the sheets before the welding metal is introduced and the weld is built up from the bottom of the sheet to the surface slowly, there is but one conclusion to be reached, and it is this—there is nothing to prohibit a proper weld that will give a high degree of efficiency when put in the tensile-strength machine; but in the majority of cases the rapidity

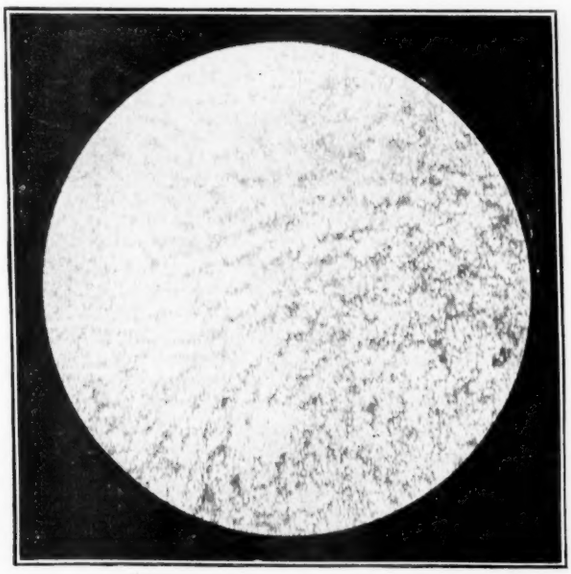


FIG. 5. SHOWS FIG. 3 MAGNIFIED 80 DIAMETERS. NOTE FLOW OF METAL

with which the molten metal is run into the seam is the one feature that mitigates against a homogeneous joint. There is not sufficient time given for the metal to set and properly knit and recrystallize with the edges of the sheet, under which conditions the best results might be expected.

The etched surfaces fail to reveal any of the objections which so many have given as a reason why oxyacetylene welding is not to be looked upon with favor in the repairing of boilers. Of course we must reckon with the human factor in all work. That is no less true in the riveting of a joint than it is in the welding of a joint, and the human factor evidently has not, in America, at least, been brought to a realization of the underlying features, chemical and mechanical, which are very necessary to the production of a good joint.

Quick repairs now demand that the oxyacetylene process be improved considerably. Repairs on large castings, and even on frames of large locomotives, were made by thermit; but the disadvantages of thermit are the advantages of oxyacetylene welding, and the preponderance of metal at any given point is not always the proper thing to have. Especially is this true with regard to flywheels, which would thus be thrown considerably out of balance, and it is also true of large engine frames which have not the proper form to permit their being enlarged at any given place without throwing out the continuity of the lines and maintaining clearances.

Figure 7 shows a welded fire crack from the girth seam of a 66-in. boiler. The plate is 13/32 in., the pitch of the

rivets is 2½ in., the rivets are ⅞ in., in a 15/16-in. hole. Fire cracks developed on this seam back to the shank of the rivet, and it was decided that repairs would have to be made by putting in a new sheet. The question arose whether or not the oxyacetylene torch might be brought into play as

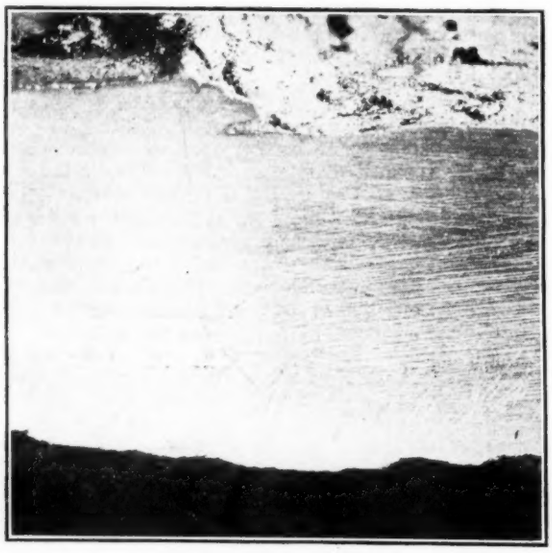


FIG. 6. ENLARGEMENT OF GROUND EDGE THROUGH WELD

an alternative in putting in a new sheet. The plate was "V'd" out in front of the rivets to give good metal with which to knit. A piece of plate was used as a welding medium, which approximated as closely as possible the tensile strength and constituency of the shell plate.

After cutting out old rivets in the seam, the sheets were heated to a dull red, and fresh metal run into position in front of the rivet holes by the acetylene torch. There was

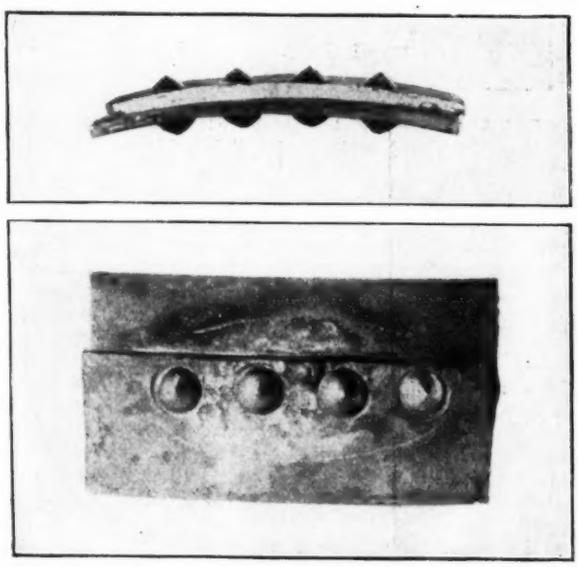


FIG. 7, TOP; FIG. 8, BOTTOM, SHOWING FIRE CRACK WELDED

no building up beyond the thickness of the plate and beyond the edge where the original plate was. After cooling, the edge of the plate was chipped, the holes reamed, rivets driven, and seam calked with a blunt-nosed tool, and the boiler was put under pressure. It has operated successfully, the fire cracks have not developed any weaknesses, although the flame from the burner is a little high, thereby impinging against the edge of the plate, having a tendency to produce additional fire cracks if continued, but the seam is such that the original efficiency has been nearly equaled, and, having the plate homogeneously welded with other plate of about the same chemical constituents, the knitting has been such that we can expect the best results consistent with the condition of the sheet at the outset.

Figure 8 is the front view of a welded fire crack after redriving rivets, the chalk line being the margin of the heated area.

Fire cracks usually burn the edge of the sheet down to a beveled edge, so that not only the very edge of the sheet oxidizes and crystallizes, but oxidization and crystallization extend back into the rivet, and especially is this true on the surface of the sheet itself. Therefore it is necessary in such cases of welding to remove the rivet, build up the sheet to the required thickness, redrill to approximate size and ream; and, strange as it may seem, if proper precautions have been taken to prevent the weld from building up, the rivets can be driven into what might be considered the original sheet, without any undue stresses or strains developing owing to unevenness of the sheet, and it is fair to presume that there are few fire cracks that cannot be properly repaired in a short time by the oxyacetylene torch if properly handled and care be taken to follow the simplest rules of mechanics.

The annual report of the Manchester Steam Users' Association, for the prevention of steam boiler explosions, and for the attainment of economy in the application of steam contains the following statements: The gross total of boiler examinations in 1917 was 22,275, which is the highest number hitherto reached in one year. No explosion has occurred from any boiler under inspection and guarantee during the year, and it may again be stated that no life has ever been lost from any cause which the association could or ought to have prevented. The service rendered during 1917 has been in many instances of special advantage to the members concerned. First inspections were made of nearly 700 boilers and pressure vessels, in addition to steam pipe ranges. About 7 per cent of the boilers required structural strengthening to render them fit for work, or were unsuited for the purpose intended. The inspections revealed many defects, and much timely advice was given as to the best means of checking deterioration and as to desirable repairs. The proportion of second-hand boilers examined before purchase has again been large, and some of these have been found quite unsuitable for the requirements for which they were submitted, although offered at very high prices. In such cases intending purchasers have seen the wisdom of consulting experts.

The high cost of coal continues to cause many of our members to consult the Engineering Department on questions of economizing in regard to the raising and the use of steam, and it is well to remember that the advice they obtain is almost uniquely free from the fetters of commercial bias as the association has no pecuniary interest whatever in patents or particular appliances. The wave of boiler mishaps mentioned in the last annual report seems to have passed away. It was attributed to the employment of inexperienced firemen owing to the exigencies of the war, but further experience and the fact that the men have come in contact with our inspectors when examining the boilers, and have had the opportunity of receiving advice, has led to their giving more intelligent and vigilant attention to their duties.

The record of Boiler Explosions for 1917 outside the association's ranks shows an extraordinary falling off, and up to the present time, we have received only five reports of inquiries by the Board of Trade under the Boiler Explosions acts. Those refer to three explosions "proper," by which two persons were killed and six injured; and two "miscellaneous" explosions, killing two persons and injuring one other.

Chief Manchley is like most of the engineers who subscribe for *Power*. He is actually the purchasing agent for supplies and new equipment in the power plant.

Does your message reach this vitally important man in the power plant?

It does if you advertise in *Power*.

Meeting, New York Section of American Society of Refrigerating Engineers

On Wednesday evening, Sept. 18, the New York Section of the American Society of Refrigerating Engineers held the first meeting of the 1918 fall season. As usual the meeting was preceded by a dinner at Machinery Club. L. Howard Jenks, chairman, presided. The section now holds five meetings a year, the last having been on May 15. The next meeting is scheduled for Nov. 20, at which a paper on "Refrigeration and the War" will be read.

At last Wednesday's meeting, Charles N. Neeson gave an informal talk on electrically operated high-speed refrigerating machines. Mr. Neeson's company has 19 high-speed refrigerating machines, all synchronous motor-driven. These machines are each fitted with a bypass as usual, but it is the experience of Mr. Neeson that they may be started much quicker and easier when the bypass as well as the suction and discharge valves are closed. This seems to be particularly true when the back pressure is high. With a back pressure of 5 lb. the machines will start with the bypass valve open full, but at 20 lb. back pressure will not start. Mr. Neeson agreed that it was because of leakage through other valves that it was necessary to shut the discharge valve on these compressors when starting. In other words, if there was no back leakage, it would not be necessary to close the valves when starting the machine.

With the introduction of the high-speed ammonia compressor, the question of valves has become a most important one. Mr. Neeson's experience may be extreme, but it shows that valves, or rather their proper selection, is a matter of unusual importance. The machines had been fitted with a certain type valve and in a short time 85 of these broke; a change of valves was made and since then none has broken. Mr. Neeson believes the reason so many valves broke was that the compressors had very little clearance. At any rate since increasing the clearance the valves do not receive the same shocks that they did before, and this may, in part, account for the almost 100 per cent. breakage of one type of valve with no breakage for the type now in service. These machines run at 234 r.p.m. The electrical end has given no trouble; in fact, the performance of the motors has been most satisfactory. They are built to carry 371 amperes but because of summer overload conditions they carry 475 amperes continuously without abnormal heating. For the small machines the volumetric clearance is 3½ per cent.; for the medium machines 7 per cent., and for the larger machines about 2 per cent. The clearance between the heads and the pistons is about $\frac{1}{16}$-in. The piston clearance in the cylinder for a 15-in. diameter piston was 0.006 in., but as one of these pistons seized in the cylinder, the engineers became apprehensive and this clearance was increased in all of the machines from 0.006 in. to 0.030 in. Despite this clearance there is no slap of the pistons in the cylinder.

Packing for the stuffing-boxes was for a time a problem. Pure rubber packing was tried, but was no use as the oil tended to soften and dissolve the rubber. When this happened knocks developed in the stuffing-box and one or two of them cracked.

Mr. Neeson said that unfortunately he could not give performance data that would be of interest, owing chiefly to the fact that the engineers have been concerned mainly with keeping the plant going and getting production, and had little time for making tests. With 18 cans per ton of ice, 35-kw.-hr. per ton was achieved and for the summer conditions, 22 kw.-hr. per ton. With a cooling-tower plant 32 kw.-hr. per ton was had, and for summer conditions 12 cans per ton, 60 kw.-hr. per ton of ice.

These compressors have center ports and indicator diagrams show a 5-lb. drop in the suction pressure, with 20 lb. excess above the head pressure at the end of compression. There is about 25 per cent. reëxpansion with the high head pressure.

The volumetric efficiency is estimated only. Figuring where the reëxpansion stopped, the volumetric efficiency equals 75 per cent. The loss in power is about 5 per cent.; that is, loss due to friction, etc. In the particular machines to which these figures relate, the volumetric clearance is 6½ per cent.

In some of the plants where these high-speed compressors are used are also the old slow-speed type machine. Mr. Neeson does not find a higher temperature for the discharge gas from the higher-speed machines than from the gas from the slow-speed machines. The piston speed in the high-speed machines is 450 ft. per min. Feather valves are used in all of them.

Current is bought on a maximum demand for the week. If the first day of the week happens to be a hot one or one on which the load is heavy, that is, heavier than it will be throughout the other days of the week, the cost of current for the week would be higher than if the conditions were reversed. Most of these compressors have cylinders 12 x 15 in., and these have been provided with clearance pockets each of which is 5 in. in diameter by 4 in. long, and which may be opened in direct communication with the cylinder or closed tight from it, thus increasing or decreasing the clearance. Mr. Neeson says that with high head pressure the use of these pockets reduces the load about 20 per cent.

Considerable discussion was had relative to starting torque, the general impression being that if the manufacturers of synchronous motors were credited with giving wide circulation to statements that 25 to 27 per cent. starting torque were fair or common figures, whereas in the opinion of some of those present, 40 to 50 per cent. seemed to be the more common operating figures. The voltage starting tap on the machines in Mr. Neeson's plants is 70 per cent. His machines run simple, that is, they are not compound machines, and there is little or no fluctuation in the ammeter when several of the machines are running in parallel. With one rope-driven machine, however, there is a swing of about 100 amperes at every revolution. Mr. Neeson mentioned that one of these machines got out of step, but why he does not know and has not yet learned. Paint had dropped down on the collector or at least was found there after the machine was examined. Mr. Hill, of Ophuls, McCreery & Hill, consulting engineers, New York City, stated that it was likely due to the excitation current being too low.

F. L. Fairbanks, chief engineer, Quincy Market Cold Storage and Warehouse Co., Boston, Mass., stated that on the whole the tendency was to give these high-speed compressors too little total valve area. With the center port compressors it is a simple matter to give them an excess valve area and in every case this is highly desirable. On the part of the operator, there is a tendency to make plate and feather valves give from two to four years' service, whereas a feather or a plate valve should be changed every six months to avoid serious recesses in the valve seats. The low cost of the valves greatly favored changing them at six month intervals and this insures tight valves.

The meeting manifested an anxious interest in the question of flywheel effect for these high-speed compressors, and particularly those of the compound type where they are driven with synchronous motors. Experience seems to show that where there are a number of these machines in one plant, any one running singly gives no trouble in the way of regulation, but when two or more of appreciably different capacities are in parallel, considerable trouble is experienced in regulation. Everybody seemed anxious for more light on this subject, but the discussion was made up of more questions than answers.

F. L. Fairbanks stated that for the synchronous-motor drive, unusual care should be taken in determining the crank effort and for an erratic crank effort, a heavy flywheel should be used and vice versa. Perhaps the best way, he said, was to average the crank effort and then use the lightest possible flywheel. In this connection Mr. Fairbanks gave a most interesting example of the effect of inertia of the reciprocating parts: With his 1000-ton compressor which has a 24-in. shaft, 28 ft. long, running at 45 r.p.m., the machine could be run with the caps and quarter-boxes out of the bearing, but at 50 r.p.m. the 150-ton shaft was lifted off the bottom bearings owing to the inertia of the pistons and other reciprocating parts.

The attendance at this meeting greatly exceeded the expectations of the committee.

The Fuel Situation in New England*

By Charles T. Main
Consulting Engineer, Boston

In his paper Mr. Main presented some of the estimated coal demands for the year beginning Apr. 1, 1918, as given out by the United States Fuel Administrator, as being 735,000,000 tons of bituminous and anthracite. This is 84,000,000 tons more than was produced last year, and, according to the Fuel Administrator, 60,000,000 tons must be saved to avert disaster this coming winter.

According to Mr. Main the principal reason for the coal shortage is that there are not sufficient transportation facilities for handling enough coal and all the raw materials, food and other supplies needed. He stated that primarily there is not a coal shortage but a transportation shortage. Going into the subject further, he gives reasons for the great increase in coal consumption, one of which is that new war industrial plants have sprung up in great number, some of them consuming from one to three million tons of coal a year. According to the New England Fuel Administration, the 1918 estimate for bituminous coal is 33,400,000 tons. The estimate for the United States Fuel Administration is 30,000,000 tons, or 10 per cent. less, and recently the United States Fuel Administration has proposed further curtailments to 25,000,000 tons on the ground that the New England estimate has been excessive. About 30,000,000 tons would meet the requirements, and as the railroads can handle but about 10,000,000, the remaining 20,000,000 must come by water transportation, which would require approximately 500,000 tonnage in shipping.

On Jan. 1, 1919, there was only 200,000 tons of coal available, due to lack of transportation, and the full coal tonnage required was reached after eight months of the year had expired, making it evident that the required 30,000,000 tons of coal will not be delivered. To make matters more serious, the reserve storage of last year was all exhausted during last winter so that there is no reserve to fall back on at the present time, and the deficit will probably be in the neighborhood of 6,000,000 tons of bituminous coal, or about 20 per cent. less than the United States Fuel Administration estimate and 30 per cent. less than the New England Fuel Administration estimate.

Coal Shortage Inevitable

After having shown that there is bound to be a coal shortage in New England this coming winter, Mr. Main discussed the question of how to get along with less coal and pointed out three ways of so doing: The first method is to eliminate and shut down what may be called the less essential industries; the second is to use substitutes, and the third is to get along with less coal, which can be accomplished by the people as a whole by preventing waste of various kinds.

A plan was suggested that the local fuel committees appoint a fuel committee of their own employees, whose duty it shall be to see that the coal is consumed and power produced economically, and that there shall be no waste of steam or power throughout the plant. An advisory engineering committee has been appointed by the Fuel Administration for the purpose of assisting the local fuel committees in the various towns and cities. This committee has prepared a pamphlet that points out where wastage may occur in a plant and gives suggestions to prevent these wastes.

In discussing the remedies to be used in order to avert disaster during the coming winter, three requirements are pointed out: The first is better organization of the transportation facilities, for which there is little chance for further improvement; second, more careful preparation of coal for shipment in order that incombustibles may be eliminated; third, economy in the use of coal and the prevention of waste in the use of power and steam.

Extracts from Bulletin No. 1 of the Advisory Engineering Committee, giving detailed suggestions for methods of saving coal in the boiler room, were incorporated in the paper.

In dealing with the subject of heating rooms, Mr. Main pointed out that it is always right to use exhaust steam for heating buildings and water. In doing this work the return should be straightened out to avoid water pockets and should also have a good pitch. No steam should be allowed to waste through steam traps, which should be so placed that they can be conveniently seen.

Another method of saving is to shut off every unnecessary lamp and also to reduce the size of lamp where possible without loss of good service. It is inexcusable to put in a high-power lamp where a low-power lamp will answer, and such practice should not be continued.

Owing to the fact that anthracite screenings can be shipped into New England easier than bituminous coal, the Fuel Administrator desires that they be used. The thermal value of anthracite screenings averages from 9000 to 13,000 B.t.u. per lb. With a good natural draft, about 25 per cent. of this coal can be burned without affecting the boiler output. In order to burn a larger percentage artificial draft is required, and grates with smaller air spaces will be required to prevent sifting of the coal into the ashpits.

Another important feature in conservation of coal is to install recording instruments which, with suitable record sheets, will give all necessary data.

A number of charts were given, such as the boiler-room records, pumping station engineer's hourly records, also a fuel and power committee organization chart giving the duties of the chairman of the Water Board, superintendent of distribution, firemen and chief engineer.

*Abstract of paper presented at the New England Water Works Convention, Sept. 11-12, 1918.

Revision of Storage Regulations

The United States Fuel Administration announced Sept. 14 a revision of the regulations governing the storage of coal by consumers listed on different preference schedules. This revision brings the practical distribution of coal into line with the statistics of production and consumption in different districts as developed during the last thirty days.

With the present very complete information coming to the distribution division of the Fuel Administration and showing exactly the production, consumption and stocks on hand in every district, it is possible not only to change where necessary certain movements of coal, but the accumulation of winter storage, which is at this time the most important element of distribution, can be made to play a very important part in getting maximum production and utilizing all available transportation most efficiently. Each week the distribution division has before it accurate figures showing the production of every mine during the week previous, also the consumption by all consumers and the accumulation of stocks on hand. If coal is taken into storage wherever possible in each district along the lines laid down by the regulations, it will militate to the advantage of both consumers and producers.

The amount of storage allotted to each district will be altered from time to time as may be necessary to carry out the plans of the distribution division for the coming winter.

This plan is designed to obtain the utmost from our transportation equipment with the least danger of any district being out of coal next winter on account of its distance from the mines.

Consumers on the preference classes recently defined by the War Industries Board are permitted to accumulate reserve stocks of bituminous coals as follows: Maine, 135 days; Massachusetts, Vermont, New Hampshire, northern New York, 105 days; Connecticut, Rhode Island, southwestern New York, 90 days; southeastern New York and New Jersey, 60 days; Delaware, east Pennsylvania, Maryland, District of Columbia, Virginia, Florida, western Ohio, 45 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 35 days; lower Michigan, 90 days.

Consumers in Class 2: Maine, 120 days; Massachusetts, Vermont, New Hampshire, northern New York, 90 days; Connecticut, Rhode Island, southwestern New York, 75 days; southeastern New York and New Jersey, 30 days;

Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, Florida, western Ohio, 40 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 30 days; lower Michigan, 75 days.

Consumers in Class 3: Maine, 105 days; Massachusetts, Vermont, New Hampshire, northern New York, 75 days; Connecticut, Rhode Island, southwestern New York, 60 days; southeastern New York and New Jersey, 40 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, Florida, western Ohio, 35 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 25 days; lower Michigan, 60 days.

Consumers in Class 4: Maine, 90 days; Massachusetts, Vermont, New Hampshire, northern New York, 60 days; Connecticut, Rhode Island, southwestern New York, 45 days; southeastern New York and New Jersey, 30 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, Florida, western Ohio, 30 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 20 days; lower Michigan, 45 days.

Consumers not on the preference list are limited to the following stocks: Maine, 45 days; Massachusetts, Vermont, New Hampshire, northern New York, 30 days; Connecticut, Rhode Island, southwestern New York, 20 days; southeastern New York and New Jersey, 20 days; Delaware, eastern Pennsylvania, Maryland, District of Columbia, Virginia, Florida, western Ohio, 15 days; western Pennsylvania, West Virginia, eastern Kentucky, eastern Ohio, 15 days.

There is no restriction on the stocks of screenings which may be accumulated by either preference or nonpreference consumers in Ohio or lower Michigan, nor is there any restriction on the stocks of Indiana, Illinois or Western coal, which consumers may obtain.

Supervision of the accumulation of stocks in accordance with these limits will be exercised by the several state fuel administrators, who are authorized to make exceptions where special conditions make it necessary.

National Safety Congress at St. Louis

Ways and means of reducing industrial accidents and conserving man power in these strenuous times of war were discussed during the week of Sept. 16 at St. Louis, Mo., where several hundred safety engineers, works managers and insurance men met in convention at the National Safety Congress. Sessions were continued during the entire week. Besides the general meetings and those devoted to public safety propaganda in a broad way, there were sectional sessions devoted to construction, mining, metals and metallurgy, woodworking, lumbering, textile manufacture, carbuilding, railway operation and other industries and their branches.

Time was when the convention work of the National Safety Congress was largely to spread the doctrine of "safety first." This is yet its labor to some extent, but in the seven years since the first congress the technique of accident prevention has developed and now papers and discussions are very largely technical. Each branch of industry has its own hazards and its special conditions affecting accident-prevention procedure. The main lesson presented, however, by the papers and discussions of every section was that continuous, persistent educational work is necessary to inaugurate and keep active any system of accident prevention. It is not safety devices alone, though these are highly important, that will reduce industrial accidents; an attitude of mind alert to risks and the ways of guarding against them must be created and maintained. This means that the safety engineers' work has to do as much with the workman and his manager as with mechanical preventives of accident. The first great task of safety engineering is educating employers and workmen to the idea of safety. This was the theme of every speaker.

A list of the speakers and their subjects would fill the page. Among them were Charles M. Schwab, of the Emergency Fleet Corporation; Dr. Thomas Darlington, of the American Iron and Steel Institute; Frank E. Norris, of the American Rolling Mill Co., and scores of others prominent in the industrial field.

Petroleum Stocks Decrease

The Geological survey reports a stock of crude petroleum on hand July 31, as 111,359,033 bbl. of 42 gal. each for eight oil fields east of the Rockies. Moderate loss in quantity moved from the wells and field storage tanks charged in July to the Gulf coast field was more than offset by the gain credited to other fields, resulting in a gain of 2.5 per cent. as compared with June, 1918, and of 2.4 per cent., as compared with July, 1917.

Additions in July to the stocks of the central and north Texas, north Louisiana and Rocky Mountain oils were insufficient to offset the current drafts on the surface reserves of eastern Oklahoma, Kansas and Gulf Coast oils, as a consequence of which there was a net depletion of stocks in excess of 3,000,000 bbl. during the month. In the fields to which this summary relates net depletion of stocks since July 31 has been about 21,000,000 barrels.

Revision of National Electrical Safety Code

The present edition of the National Electrical Safety Code designated as Circular No. 54 of the Bureau of Standards has been exhausted, and before reprinting, the text of the rules will be revised. This revision is now under way, and the Bureau of Standards is anxious to secure from all interested parties comments and suggestions for change of or for additions to the present rules which will improve them. Changes to be adopted must be such as will reduce accident hazards and must be reasonable and practicable. They should be supported by citation of specific instances or other evidence when possible, and should be addressed to the Bureau of Standards, Washington, D. C.

A list of proposed changes to Part 3 of the Safety Code has already been prepared and copies have been sent to the committees of technical and utility associations, state commissions and others who have been coöperating with the bureau in the formulation and revision of the rules. Similar lists of proposals for the other parts of the code are now being prepared.

Ship Design and Ship Construction

Under the auspices of the Education and Training Section of the United States Shipping Board, Emergency Fleet Corporation, the Massachusetts Institute of Technology is arranging to convert young engineers and architects into naval architects and shipbuilders to aid in designing and constructing vessels for America's great fleet of merchant ships. As the supply of technically trained men is not sufficient to meet the demands of the shipyards, the institute will increase the supply in a ten weeks' course of instruction beginning Sept. 30, at Cambridge, Mass.

Applicants desiring to be enrolled in this school should be graduates of civil, mechanical, electrical, mining or architectural engineering courses. If not graduates, they should have the equivalent of such training.

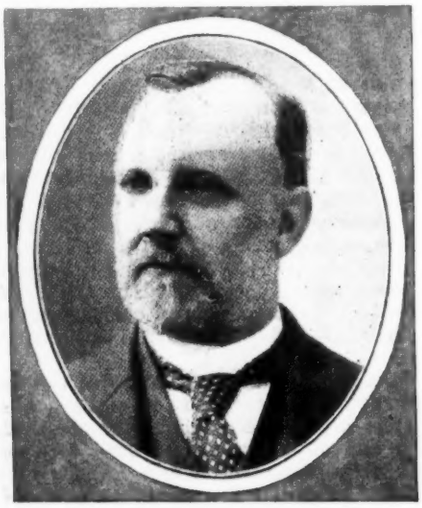
Men who have completed their junior year in college in any engineering course mentioned will also be accepted if the school is not previously filled with graduates or the equivalent as specified. Those who pursue this intensive training course are expected to devote their entire time to it for ten weeks.

"Extravagance costs blood, the blood of heroes," said Lloyd George. War savers are life savers. The sinews of war are sustained by thrift. The war cannot be won by stored-up resources, for a nation lives from hand to mouth. We must save out of the present products of labor. The British people had to learn, as we must learn, that goods and service must be saved by all. Saving must become a habit.—*Publicity Magazine.*

Locomotive manufacturers delivered 203 locomotives to the railroads in August, of which 92 came from the American Locomotive Co., 86 from Baldwin Locomotive Works and 25 from the Lima Locomotive Corporation.

William Kent

Mechanical-engineering circles were shocked by the news that William Kent had died at Gananoque, Ont., on Sept. 18. Mr. Kent was born in Philadelphia on Mar. 5, 1851. He graduated from the Central High School there in 1868, entered Stevens Institute in 1875 and graduated in 1876. During this period and afterward, until 1879, as time permitted, he assisted Prof. R. H. Thurston on the United States Board appointed to test iron and steel and other metals. From that time until 1890 he held many important positions as mechanical engineer and superintendent in various large iron and steel works and boiler manufactories, including the Torsion Balance Scale Co.'s factory where he developed the torsion balance. From 1895 to 1905 he was associate editor of *Engineering News*, and then for five years was dean of the L. C. Smith College of Applied Science of Syracuse (N. Y.) University. Since that time



WILLIAM KENT

he had practiced as a general consulting engineer. He contributed numerous valuable papers and discussions to the engineering societies in which he held membership, and to technical journals, and wrote many technical books, among which is Kent's "Mechanical Engineers' Pocket Book," reaching its ninth edition in 1915. He had taken out more than twenty patents on weighing machines, boilers, smokeless furnaces, etc. He was an active member of many engineering societies from 1876 in their order as follows: The American Institute of Mining Engineers, member of the board of managers for two years; American Association for the Advancement of Science, vice president for one year; Engineers' Society of Western Pennsylvania, treasurer for two years; American Society of Mechanical Engineers, manager three years, vice president one year; American Society of Heating and Ventilating Engineers, member board of governors, vice president and president; Society for the Promotion of Engineering Education and the Engineers' Club of New York. He was also a member of many college fraternities. He is survived by a widow, daughter and two sons.

The Construction Division of the War Department has been authorized to erect a 4000-kw. power plant with all the necessary equipment, for the Milton Manufacturing Co. at Milton, Penn. This company is manufacturing supplies for the Army and its power equipment is inadequate to meet the urgent demands of the Army. The estimated cost of the buildings and equipment is $350,000. The Milton Manufacturing Co. will eventually take over this power plant, paying for it by deducting a certain price per shell in future contracts. In the event that this method of payment does not meet the cost, provision is made to repay the balance within two years after the cessation of hostilities.

Silvering Brass and Copper Articles

Dissolve scrap silver in strong nitric acid, diluted with about half its bulk of water. Be sure always to pour the acid into the water and not vice versa, always stirring the mixture, which should be kept in a glass bottle or porcelain saucer. If the acid is slow in attacking the silver, warm it gradually. When the silver is dissolved, dilute the solution with a quart of water and pour a solution of common salt and water gradually into the nitrate of silver solution. A dense precipitate of chloride of silver results. Collect the chloride of silver by filtering through filter paper, wash it several times and dry it. Then mix the substance with three times its own bulk of table salt and twice its own bulk of cream of tartar, taking care to mix the ingredients thoroughly. It is then ready for use. This is rubbed on the brass or copper article with a wet cotton rag. After the silvering is complete, wash the article with hot water, and varnish it to prevent tarnishing. The unused silvering solution should be put into a bottle and set in a cardboard box and stored in a dark place to prevent it turning black.—*The Indian Engineer, Bombay.*

Bursting Feed Water Pipe Causes Panic

Upon investigating the report that a steamboat boiler had burst, it develops that the accident was merely that of the bursting of a feed-water pipe, on the steamer "Julius Stafford." According to newspaper reports the boiler exploded, the boiler tubes burst, and the main steam lines burst, all depending upon in which paper the account was read.

This accident happened Saturday, Sept. 21, on the little double-deck steamer that carries workers to and from the Shooters Island shipyard of the Standard Shipbuilding Co. When the blowoff pipe burst the flying hot water caused such a panic among the 200 workmen on the steamer that a number of them jumped overboard. It is reported that two men are missing. About a dozen were more or less scalded, but it is understood none of them seriously so.

An Emergency Salinometer

First obtain a slender bottle, and place a small amount of shot in it, and cover the latter with wax or paraffin. Place the prepared bottle in fresh water, and mark the water level upon the bottle at the flotation point. This will be the zero of the scale to be made. Take a gallon of sea water and proceed to determine the $\frac{1}{32}$ reading. Then take two gallons of sea water and boil it until one gallon remains. Then, as before, determine the $\frac{2}{32}$ flotation point. In like manner boil three gallons of sea water until one remains, and determine the $\frac{3}{32}$ point. (The foregoing procedure only applies when the sea water used is of $\frac{3}{32}$ salinity; the waters of the Atlantic and Pacific Oceans are very nearly $\frac{1}{32}$ saline.) Thus the bottle has graduations for 0, $\frac{1}{32}$, $\frac{1}{16}$ and $\frac{3}{32}$ salinity, and may be used successfully as a salinometer.

Creed for Americans

I believe that the cause of the United States and the Allies is a just cause and makes for righteousness.

I believe the Kaiser and the Potsdam gang cannot make a treaty we have any right to approve.

I believe we do not discharge our duty to ourselves and the world till we have fought this war to a victory over the Kaiser and the Potsdam gang and the German Government as it is at present constituted.

I believe all our energies during the next three years should be devoted to raising an army of 5,000,000 men and the ships necessary to transport them to France, and the supplies necessary to them to fight this war.

I believe we are going to win this war.

—*Former President William H. Taft.*

New Publications

DIRECTORY OF THE AMERICAN ASSOCIATION OF ENGINEERS. A directory of engineers, giving a brief synopsis of the experience and training of all members of the association, issued for the good of the members and as an aid to the employer of engineers. Published by American Association of Engineers, 29 South LaSalle St., Chicago, Ill. Cloth, 6 x 9 in.; 192 pages. Price, $2.

This directory of the American Association of Engineers improves upon the common society year book and is an actual engineer's directory. It gives a brief synopsis of each member's experience and training, which will be of definite usefulness to the employer of engineers, who will be able to tell whether an applicant fills his needs without the loss of time from unnecessary interviews. Classified tables have been compiled based on experience, so that it is possible to find a consulting engineer, an executive or a subordinate having specific experience and living in any definite locality. Thus if one needs a consulting hydraulic engineer, or a designer of machine parts, he is able to find men having this experience through the aid of the classified tables. The 2204 members registered in the directory are divided according to experience, as follows: Members having civil engineering experience, 71.9 per cent.; members having mechanical engineering experience, 24.8 per cent.; members having electrical engineering experience, 12.8 per cent.; members having mining engineering experience, 5.7 per cent.; members having chemical engineering experience, 2.9 per cent.

The membership is divided as follows: Consulting (practicing engineers) 10.3 per cent.; contractors, 1.2 per cent.; patent attorneys, 0.5 per cent.; executive (officials, managers, superintendents, etc.) 40.4 per cent.; assistants, draftsmen, etc., 42.5 per cent.; students, 5.1 per cent. Over 20 per cent. of the members of A. A. E. are on the Association's Service Roll.

TECHNICAL PAPER 144 OF THE BUREAU OF MINES

This paper deals with the quick determination of incombustible matter in coal and rockdrift mixtures in mines, and was written by A. C. Fieldner, W. A. Selvig and F. G. Osgood. The paper is free to those who ask for it.

MEASURING THE TEMPERATURE OF GASES IN BOILER SETTINGS

This bulletin, No. 145, is issued by the Bureau of Mines, Washington, D. C. The price is 15c. It is one of a series of publications for the purpose of disseminating information in regard to the methods by which the fuel in this country may be used most efficiently. A knowledge of the temperature of the gases in boiler settings and in other commercial apparatus usually tends to develop new design of apparatus and better methods of operating, thus reducing waste of fuel. The bulletin is for the benefit of those designing, operating and testing such apparatus, presenting information as to the accuracy of temperature measurements made under certain conditions and the corrections that can be safely applied. The bulletin presents the results of a series of measurements of the temperatures of gas in the most common types of boilers, discusses the errors occurring in the usual methods of measurement and gives directions for making and using inexpensive thermocouples for determining flue-gas temperature.

The material in the bulletin is presented in three parts: the first contains the results of a series of measurements of temperatures of the gases within the settings of five types of boilers. The second part, which explains why the readings attained with small-sized couples are nearer to the true temperatures of the gases than those attained with large couples or other large instruments, shows the relation between the magnitude of radiation error and the size of the couple. The third part contains a discussion of the various instruments used in the tests and also directions for making a copper-constantan thermocouple—and using it for measuring the temperatures of flue gases.

Personals

A. J. Barnes has been appointed export manager of the Shepard Electric Crane and Hoist Co., Montour Falls, N. Y. He will also continue to be director of publicity.

Prof. Ira N. Hollis, president of Worcester (Mass.) Polytechnic Institute, and past president of the American Society of Mechanical engineers, has been appointed United States Fuel Administrative Engineer for Massachusetts.

Osborn Monnett, formerly Western Editor of "Power" and more recently smoke inspector of the City of Chicago, has been appointed assistant advisory engineer to the Conservation Bureau of the United States Fuel Administration.

Charles Gollmar has resigned as purchasing agent for R. D. Nuttall Co., Pittsburgh, Penn., to take a similar position with the Locomotive Stoker Co., of the same city. R. M. Lawley will succeed Mr. Gollmar in the former position.

Victor J. Azbe has resigned as combustion and refrigerating expert for the Anheuser Busch Breweries, and has opened an office at 2194 Railway Exchange Building, St. Louis, Mo., as a power-plant, combustion and refrigeration engineer.

B. H. Tripp, special representative of the Chicago Pneumatic Tool Co. on the Pacific Coast, has succeeded M. W. Priseler as district manager of sales for the Pacific Coast territory, with headquarters at 627 Howard St., San Francisco. The Los Angeles branch of the company at 521 Title Insurance Building comes under Mr. Tripp's jurisdiction.

C. A. Graves has been appointed Administrative Engineer for New York State, by Delos W. Cooke, State Fuel Administrator, in place of E. N. Trump, of Syracuse, resigned. He was formerly assistant administrative engineer in charge of the New York-Metropolitan district. Mr Graves is president of the Graves Engineering Co., which he formed about five years ago to do general consulting power-plant work. He is also vice president of the Southern New York Power and Railway Corp. Previous to forming the Graves Engineering Co., he was power engineer for the Edison Electric Illuminating Co., of Brooklyn, and previous to that was superintendent of power for the Peckham Manufacturing Co. He has been prominent in Brooklyn engineering and civic matters. He has also been a member of the executive committee of the Empire State Gas and Electric Association.

Miscellaneous News

Work on the $1,000,000 Power Plant at Lorain, Ohio, was recently resumed upon receipt of word from the Government that a loan of $500,000 would be made and materials furnished.

A Boiler Exploded in the oil fields of the Gulf Refining Co., on the Noel lease, Pine Island district, north of Shreveport, La., on Sept. 18, instantly killing four workmen who were at the rear of the boiler. The explosion blew some of the men three hundred yards and the bodies were badly mangled.

The New York School of Heating and Ventilating announces the opening of its sixth annual season, 1918-19. Registration for classes will be held on Monday evening, Oct. 7. The first-year class will meet every Monday evening at 7:30 o'clock in Room 511, World Building, and the second year class at 5:45 o'clock in the same room on same evening. The first sessions of both classes will be held on Monday, Oct. 14.

Trade Catalogs

Stratton Air Separator. The Griscom-Russell Co., New York City. Bulletin No. 1110. Pages 7, 6 x 9 in.; illustrated.

The Poole Engineering and Machine Co., of Baltimore, Md., has just issued folder No. 203, which briefly describes its turbo-gear mine fan drive.

The Crescent Belt Fastener Co., of New York City, has just issued its Service Chart Form N. Y. 201, giving sizes, prices and instructions for all kinds and makes of belting.

The Lagonda Reseating Machine. The Lagonda Manufacturing Co., Springfield, Ohio. Bulletin G-2. Pages 7, 6 x 9 in. Describes and illustrates electric, air, steam and water driven reseating machines. Free copy on request.

Bulletin No. 48938 of the Sprague Electric Works of the General Electric Co., West 34th St., New York City, describes a grab-bucket power hoist that can shovel, lift, convey, deposit and recover coal or other material. The capacities of these buckets, which are electrically driven, range from ¾ cu.yd. to 1½ cu.yd. The bulletin is 8 x 10½ in. and contains 23 pages.

New Construction

PROPOSED WORK

Mass., Hopedale—The Hopedale Cemetery Association has awarded the contract for the erection of a 21 x 31 ft. mausoleum in Hopedale Cemetery to E. F. Miner Building Co., 25 Foster St., Worcester. A small boiler and steam heating system will be installed in same. Total estimated cost, $40,000.

Conn., Waterbury—The Waterbury Buckle Co., 872 South Main St., is receiving bids for the erection of a 3-story, 46 x 109 ft. factory. Equipment including motors, belting, shafting and conveyors will be installed in same. Total estimated cost, $40,000.

N. Y., Carthage—The National Paper Products Co., 126 Canal St., is receiving bids for the erection of a 3-story, 60 x 200 ft. paper mill; plans include the erection of 200 h.p. power plant. Total estimated cost, $60,000. C. Eaton, Sherman Bldg., Arch.

N. Y., Utica—The Frisbie and Stansfield Knitting Co., 421 Broad St., is receiving bids for the erection of a 1-story, 60 x 120 ft. addition to its mill; equipment, including motors and belting will be installed in same. Total estimated cost, $25,000.

N. Y., Yonkers—The New York Engineering Co., 2 Rector St., New York City, plans to build a 1-story, 98 x 200 ft. boiler house.

N. J., Newark—The Passaic Valley Sewerage Commission will receive bids until Oct. 8, for furnishing and erecting six complete sets of sewerage screens, including all driving mechanism, screen guides, roughing screens, switchboards and all other appurtenant work for the Newark Bay Pumping Station.

N. J., Passaic—The New York Belting & Packing Co., 91 Chambers St., New York City, N. Y., has awarded the contract for the erection of a 1½ story, 60 x 150 ft. power house to J. W. Ferguson, United Bank Bldg., Paterson. Estimated cost, $150,000. The company is in the market for boilers, pumps and coal bunker.

Penn., Ardmore—The Auto Car Co. is receiving bids for the erection of a 75 x 125 ft. heat treating plant.

Penn., Beaver Brook—The C. M. Dodson Coal Co. is in the market for electric pumping machinery, for installation in colliery No. 5.

Penn., Milton—The Construction Division has been authorized by the War Department to erect a 4000 k.w. power plant with all necessary equipment for the Milton Manufacturing Co. Estimated cost, $350,000. This company is manufacturing supplies for the Government and its present power equipment is inadequate to meet the urgent demands of the army. The Milton Manufacturing Co. will eventually take over this power plant, paying for it by deducting a certain price per shell in future contracts.

N. C., Wilmington—The Lingo City Metal Works is in the market for two 125 h.p. boilers.

Ga., Jackson—The Citizens Ice & Storage Co. plans to build a 30 x 60 ft. ice manufacturing plant.

Ky., Lexington—The University of Kentucky is in the market for low-pressure steam boiler having about 30,000 sq.ft. radiation capacity. A. O. Whipple, Supt. of Bldgs. & Grounds.

Ohio, Cambridge—The National Coal Co., 1503 Rockefeller Bldg., Cleveland, will install a steam heating system in the 1-story, 150 x 250 ft. machine shop which it will build. Total estimated cost, $70,000. E. C. Murray, Engr.

Ohio, Canton—The Dime Savings Bank, 300 Tuscarawas St., will install a steam heating system in the proposed 3-story, 67 x 120 ft. addition to its bank building. Total estimated cost, $100,000. Hoggson Bros., 485 5th Ave., New York City, N. Y. Arch.

Ohio, Cleveland—The National Carbon Co., West 117th St., will install a steam heating system in the proposed six, 1-story, factory buildings which it plans to erect on Berea Rd. Estimated cost, $100,000.

Ohio, Cleveland—The Sacred Heart of Mary congregation, 4419 Pearl Road, will install a steam heating system in the proposed 1-story, 62 x 156 ft. church at 4223 Pearl Road. Total estimated cost, $125,000. H. A. Walsh, Lennox Bldg., Arch.

Ohio, Lodi—Harrisville Lodge 137 will install a steam heating system in the proposed 2-story, post office and lodge. Total estimated cost, $50,000.

Ohio, Lorain—The B. & O. Railroad Co. plans to build 1- and 2-story railroad shops. Plans include the erection of a boiler house, locomotive repair shop, etc. Total estimated cost, $150,000. H. A. Lane, Ch. Engr.

Ohio, Lorain—The Cromwell Steel Co. is in the market for a 35 h.p. double friction drum electric hoist, designed for 220 d.c. motor

Ohio, Lorain—The Union Chemical Co., Union Bldg., Cleveland, has awarded the contract for the erection of a chemical plant consisting of eighteen 1- and 2-story buildings, to J. Hott & Co., 1340 Chestnut St., Philadelphia, Penn. Project includes a complete power plant. Total estimated cost, $1,000,000.

Ohio, Mansfield—The Hughes Keenan Co., 206 North Mulberry St., will install a steam heating system in the 1-story, 100 x 200 ft. factory which it plans to build. Total estimated cost, $40,000.

Ohio, Salem—City plans to issue $20,000 bonds to improve water-works; $15,000 to be spent immediately for the electrification of the water plant and the remaining $5000 for meters. Plans include new pumps at West Main St. Station, small compressor at Garfield well field and three new deep well pumps for Whinnery well field. J. Connors, Dir. of Pub. Serv.

Mich., Battle Creek—State has awarded the contract for the erection of a community house at Camp Custer, to Chas. Hoertz, Grand Rapids. Heating, plumbing and lighting will be installed in same. Total estimated cost, $250,000.

Mich., Detroit—The Board of Education, 50 Broadway, plans to build a 50 x 100 ft. power plant on Henry St. between 2nd and 3rd St. Plans include the installation of two 340 h.p. boilers, high pressure auxilliary feed water pump and heater, and vacuum pumps. Estimated cost, $125,000. Malcolmson & Higginbotham, 404 Moffat Bldg., Arch.

Mich., Detroit—The Polonia Baking Co., 420 30th St., will install boilers and ovens in the 3-story, 53 x 156 ft. bakery plant which it plans to build on 31st and Herbert St. Estimated cost, $100,000.

Mich., Port Huron—The Robeson Preserve Co., 208 Merchants St., will install a steam heating system in the proposed 1-story, 60 x 140 ft. factory. Total estimated cost, $30,000. J. W. Corbusier, Lenox Bldg., Cleveland, Ohio, Arch.

Ill., Chicago—The Municipal Tuberculosis Sanitarium, 105 West Monroe St., has awarded the contract for the erection of a 1-story, 77 x 125 ft. auditorium on Bryn Mawr and Crawford St. to E. V. Johnson, 80 East Jackson St. Extensions to the existing heating plant are planned. Total estimated cost, $100,000.

Wis., Ladysmith—Menasha Paper Co. plans to install a 500 h.p. generator at pulp mill. J. C. Jacobson, First National Soo Line Bldg., Minneapolis, Minn., Engrs.

Minn., St. Paul—C. T. Miller, 506 New York Life Bldg., has awarded the contract for the erection of a 7-story hospital on College Ave., to the George J. Grant Construction Co., 907 Exchange Bank Bldg. A steam heating system will be installed in same. Total estimated cost, $600,000.

Kan., Buffalo—City election voted in favor of a $20,000 bond issue for a municipal light plant. W. B. Rollins, 209 Railway Exchange, Kansas City, Mo., Engrs. Noted Sept. 10.

Mo., Joplin—The Connor Hotel Co., 4th and Main St., will install a steam heating system in the proposed 2-story laundry, engine room, etc., which it plans to build and is in the market for an engine, boilers, and laundry equipment. Total estimated cost, $36,000. A. C. Michalis, Miners Bank Bldg., Arch.

Mo., St. Louis—The Pan Electric Manufacturing Co., 735 South 4th St., plans to build an administration building and laboratories near 4092 Bingham St. Plans include the erection of a power plant. Total estimated cost, $50,000. W. C. Forder in charge.

Okla., Tulsa—The St. Louis & San Francisco Ry. plans to erect a central heating plant for station, depot and parked pullmans. Estimated cost, $15,000. V. K. Hendricks, St. Louis, Mo., Ch. Engr.

Calif., Los Angeles—H. J. Lelande, Co. Clk., will receive bids until Oct. 7, for the construction of a low pressure steam heating system for the county tuberculosis sanitarium at Sylmar.

Ont., St. Marys—The St. Marys Wood Specialty Co. is in the market for a 30-40 h.p. automatic engine.

Ont., Toronto—The A. B. Ormsby Co., Ltd., is in the market for a motor, 20 or 35 hp., 720 revolutions, 3 phase, 550 volts, 25 cycle, alternating.

CONTRACTS AWARDED

Conn., Waterbury—The Board of Education has awarded the contract for the installation of a steam heating system and boiler in the proposed Duggan School, to M. J. Daly & Sons, 543 Bank St., $27,254.

N. Y., Bath—J. S. Maxwell, Pres. Bd of Mgrs., New York State Soldiers & Sailors Home, has awarded the contract for repairing the heating system to the Hogg & Lynn Co., Inc., 165 Lake St., Elmira, $12,779. Noted Sept. 10.

N. Y., Ilion—The Remington Arms Co. has awarded the contract for the erection of a 1-story, 38 x 66 ft. power plant, to Gleason & Co. Estimated cost, $30,000.

N. J., Bordentown—City has awarded the contract for the installation of two electrically driven centrifugal pumps and two motors at Bordentown Pumping Station, to W. R. Thropp Sons Co., 968 East State St., Trenton. Estimated cost, $5,579. Noted Aug. 27.

N. J., Jersey City—Swift & Co., 154 9th St. has awarded the contract for the installation of electric light and power system in the new plant on Henderson St. to W. Coleman, Willow Court. Estimated cost, $5000. Noted May 7.

Minn., St. Peter—The State Board of Control, St. Paul, has awarded the contract for the erection of a low pressure steam heating system in the proposed 3-story, 40 x 160 ft. dormitory at the Hospital for Insane, here, to M. J. O'Neil, 97 East 8th St., St. Paul; cost $6000. Noted Aug. 13.

WASHINGTON, D. C.

The Bureau of Supplies and Accounts, Navy Dept., will soon receive bids for furnishing following equipment:

Schedule 6036½, grinder and motor, delivery Philadelphia, Pa.

Schedule 6048½, motor generator sets, delivery San Diego, Cal.

Schedule 6186½, power driven saws, delivery Portsmouth, Va.

Bids were received by Bureau of Supplies & Accounts, Navy Dept., for furnishing equipment as follows:

Schedule 5868½, Class 721, 25 generator sets and spare parts, generators, direct current, kerosine or gasoline engine, delivery Brooklyn, N. Y., from Copley Manufacturing Co., 398 5th Ave., New York City, N. Y., $16,338, alternate $15,000; Dilwood Manufacturing Co., $26,358; Domestic Engineering Co., East Middle St., Hanover, Engineering Co., 1st and Canal St., Dayton, Ohio, $6953; General Gas Electric Co., East Middle St., Hanover, Penn., $5770; Mathews Enginering Co., Monroe and King Sts., Sandusky, Ohio, $7003; Lalley Electric Light Corp., 1823 Mt. Elliott St., Detroit, Mich., $8038.

Schedule 5853½, Class 766, two or more boilers, rated 4000 h.p., delivery Yorktown, Del., from Casey-Hedges Co., Chattanooga, Tenn., $7600, alternate, $8980; Connelly Boiler Co., Ivanhoe Rd., Cleveland, Ohio, $14,358, alternates $17,448 — $22,160; Wickes Boiler Co., 90 West St., New York City, N. Y., $9298; Nagle Engine & Boiler Works, 16th and Holland St., Erie, Penn., $9200; Heine Safety Boiler Works, Pennsylvania Blvd., Philadelphia, Penn., $19.42 per h.p.; Roberts Safety Water Tube Boiler Co., Oakland St., Red Bank, N. J., $30 per h.p.

Schedule 5856½, Class 769, four electric hoists, delivery Iona Island, N. Y., from Alfred Box & Co., Inc., Front and Poplar Sts., Philadelphia, Penn., $564; Detroit Hoist & Machine Co., Clay St., Detroit, Mich., $375, alternate $520; A. B. Granger Co., 15 Park Row, New York City, N. Y., $538; General Electric Co., 120 Broadway, New York City, N. Y., $465; Yale & Towne Manufacturing Co., 9 East 40th St., New York City, N. Y., $437; Ricker Manufacturing Co., 239 North Water St., Rochester, N. Y., $543; Shepard Electric Crane & Hoist Co., Bulletin Bldg., Philadelphia, Penn., $465.

Schedule 5746½, Class 546, electric hoists, delivery Boston, Mass., from Alfred Box & Co., Front and Poplar Sts., Philadelphia, Penn., $2852; Detroit Hoist & Machine Co., Clay St., Detroit, Mich., $2250; Shepard Electric Hoist Co., Bulletin Bldg., Philadelphia, Penn., $2850; General Electric Co., River Rd., Schenectady, N. Y., $2670.

Schedule 5682½, Class 576, power press, delivery Wash., D. C., from E. W. Bliss Co., Adams and Plymouth St., Brooklyn, N. Y., $300; Monarch Machinery Co., 300 North 3rd St., Philadelphia, Penn., $499; Perkins Machine Co., Warren, Mass., $265; D. H. Stoff Co., Buffalo, N. Y., $365; Sherritt & Stoer, Finance Bldg., Philadelphia, Penn., $319; F. J. Swain Manufacturing Co., 7th and O'Fallon St., St. Louis.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck.	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.30
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10, other rates p. 95.

PRICES—MATERIALS AND SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in		80c. per ft.
Common, 2½-in		25%

	Air		
	First Grade	Second Grade	Third Grade
½-in. per ft	$0.65	$0.40	$0.30

Steam—Discounts from List

First grade..... 15% Second grade.....25% Third grade.....33⅓%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 50% Best grade..... 30%
Standard..... 40%

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40+5%	35%
St. Louis	45%	40%
Chicago	45%	40%
Birmingham	35%	40%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.99
Asbestos for high-pressure steam	1.76
Duck and rubber for piston packing	1.10
Flax, regular	.99
Flax, waterproofed	1.21
Compressed asbestos sheet	1.10
Wire insertion asbestos sheet	1.32
Rubber sheet	.66
Rubber sheet, wire insertion	.99
Rubber sheet, duck insertion	.55
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.21
Asbestos wick, ½- and 1-lb. balls	.75

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure..... List

For low-pressure heating and return lines { 4-ply..... 58⅓% off; 3-ply..... 60% off; 2-ply..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5½	13	8½	12½
Fiber or sponge	8	6	13	8½	20
Transmission	7	6	13	9	20
Axle	4½	4	4.1	3½	5½
Gear	4½	4½	7.0	8½	9
Car journal	22 (gal.)	3½	4.3	5½	8½

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	11.00 to 13.00	13.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	12.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$52.00	$58.00
Chicago	48.00	50.00

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw per barrel	$1.90	$1.23	$2.10	$1.30	$2.05	$1.27
5-gal. cans	2.00	1.33	2.25	1.40	2.25	1.32

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	14.00	15.50	13.25	13.50	14.00	13.00
25- and 50-lb. kegs	14.25	15.75	13.50	13.75	14.25	13.25
12½-lb. keg	14.50	15.90	13.75	14.00	14.50	13.50
5-lb. cans	.....	.....	15.25	15.50	16.00	15.50
1-lb. cans	.....	.....	.....	.....	17.00	.....

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	45-5%	45%
Tinned	30%	45-5%	45%

Button heads, ½, ¾, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York...$5.65 Cleveland...$5.15 Chicago....$5.67 Pittsburgh...$4.65

Coneheads, same sizes:

New York...$5.75 Cleveland...$5.25 Chicago....$5.77 Pittsburgh...$4.75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$175.00
Chrome cement	net ton	75.00
Clay brick, 1st quality fireclay	per 1000	50.00– 55.00
Clay brick, 2nd quality	per 1000	35.00– 40.00
Magnesite, raw	per ton	30.00– 35.00
Magnesite, calcined	per ton	32.00– 35.00
Magnesite, dead burned	net ton	32.00– 35.00
Magnesite brick, 9 x 4½ x 2½ in	net ton	110.00–125.00
Silica brick	per 1000	50.00– 60.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55; St. Louis grade, $40.
Birmingham—Fire clay, $55-60; silica, $55-60.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	95.00	70.00	93.00	73.00	96.00	70.00
Commercial	50.00	40.00	23.00	22.00	25.00	25.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$16–19	$14.00
Cleveland	20.00	15.00
Chicago	19.00	13.00

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft	$5.82	$5.17	$4.55	$5.17
7 in. by 30 ft	7.65	6.85	6.10	6.85
7 in. by 35 ft	11.10	10.00	8.95	10.00
8 in. by 35 ft	12.65	11.35	10.10	11.35
7 in. by 40 ft	12.85	11.50	10.20	11.50
8 in. by 45 ft	18.90	16.90	15.00	16.90
8 in. by 50 ft	22.65	20.30	18.00	20.30

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9.00
12-in. butts, 6-in. tops, length 30-40 ft	11.50
12-in. butts, 6-in. tops, length 41-50 ft	12.50
14-in. butts, 6-in. tops, length 51-60 ft	21.00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron	
Inches	Black	Galvanized	Inches	Black	Galvanized
¼ to 3	49%	35½%	⅜ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	.....	7 to 8	20%	8%
15	30%	.....			

BUTT WELD, EXTRA STRONG PLAIN ENDS

¼ to 1½	47%	34½%	⅜ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
⅜ to 3 in. butt welded	33%	42%	37%
3½ to 6 in. lap welded	15%	38%	33%

	Galvanized		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	16%	26.9%	22%
3½ to 6 in. lap welded	+3	23.9%	19%

Malleable fittings, Class B and C, from New York stock sell at list from list prices. Cast iron, standard sizes, 10 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2¾ to 3¼ in.	24	3 to 3½ in.	+ 5
2½ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1⅞ to 1¾ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled

Per Net Ton		Per Net Ton	
1 in.	$340	1¼ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$222.00
No. 12 solid	135.00	170.00	211.00	290.00
No. 10 solid	185.00	235.00	255.00	325.00
No. 8 stranded	235.00	325.00	345.00	450.00
No. 6 stranded	370.00	472.00	625.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	10%
Coils to 1,000 ft.	15%
1,000 ft. and over	

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready:

	Each, Net
Less than 12	$0.40
12 to 50	.35
50 to 125 (bbl.)	.31
125 (bbl.) or over	.28

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	.0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	446.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.	
⅜	250	$0.05½	Coils, 55% Off. Less coils, 40% off
½	250	.06	
⅝	250	.09	
¾	200	.12	
⅞	200	.15	
1	150	.18	
1	100	.25	
1¼	100	.33	
1½	Odd lengths	.40	
2	Odd lengths	.55	

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	.....
T. P. S. B.	.81	1.80	.....
D. P. D. B.	.78	2.10	.....
T. P. D. B.	1.35	3.60	.....
T. P. to D. P. D. B.	.90	2.52	.....

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$20.00
No. 16 cotton twisted	24.50
No. 18 cotton parallel	21.00
No. 16 cotton parallel	28.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	38.00
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No. 18 cotton Canvasite cord	25.00
No. 16 cotton Canvasite cord	32.00

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
0-amp. to 600-amp.	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.20 C
0-30 ampere, less than standard package	5.00 C

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.21
Hubbell composition No. 5467, standard package 50	.28
Benjamin swivel No. 903, standard package 250	.15
Hubbell current taps No. 5638, standard package 50	.35

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$14.00	$16.00	$27.00
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	.....	.....	56.00	.....
4	.....	.....	76.40	.....
2	.....	.....	112.45	.....
1	.....	.....	152.26	.....
0	.....	.....	182.90	.....
00	.....	.....	223.60	.....
000	.....	.....	271.24	.....
0000	.....	.....	332.40	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$15.00	$20.00	$35.00	$21.00	$16.00	$33.00	$11.50	$17.80	$36.30
10	25.65	26.90	57.45	27.20	31.00	69.00	31.80	34.30	67.60
8	36.45	40.25	80.30	38.00	42.00	78.00	42.85	46.85	.....
6	57.40	61.70	.....	.....	65.00	130.00	69.60	74.10	.....
4	83.40	88.70	.....	.....	93.00	.....	101.75	151.55	.....
2	126.60	132.80	.....	.....	140.00	.....	151.50	168.00	.....
1	164.15	172.40	.....	.....	182.00	.....	201.00	254.50	.....
0	206.80	206.80	.....	.....	242.00	.....	276.00	285.00	.....
00	278.80	278.80	.....	.....	290.00	.....	317.00	330.00	.....
000	341.65	341.65	.....	.....	360.00	.....	417.00	428.50	.....
0000	417.05	417.05	.....	.....	435.00	.....	507.00	516.04	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap.			¾ In. Cap	
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package +10%
1-5th to standard package + 8%
Standard package −25%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	46c. lb.
No. 18 B.&S. regular 1-lb. coils	47c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 40c. lb., 100 lb. lots	38c. lb.
Rubber tape, ¾ in., less 100 lb., 48c. lb., 100 lb. lots	45c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	5%
$10 to $25 list value	16%
$25 to $50 list value	24%
$50 to $200 list value	28%
$200 list value or over	31%